Dr. Cannan

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SCIENCE

26 August 1960

Vol. 132, No. 3426

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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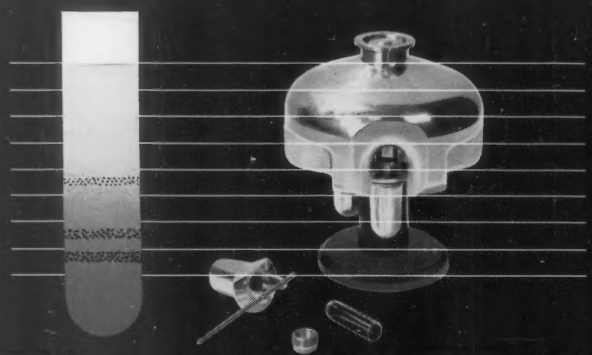

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Gradients can be formed either before centrifugation begins, by layering solutions of different concentrations of a substance such as sucrose—or they can be formed during centrifugation by the redistribution of a material like cesium chloride under the influence of centrifugal force.

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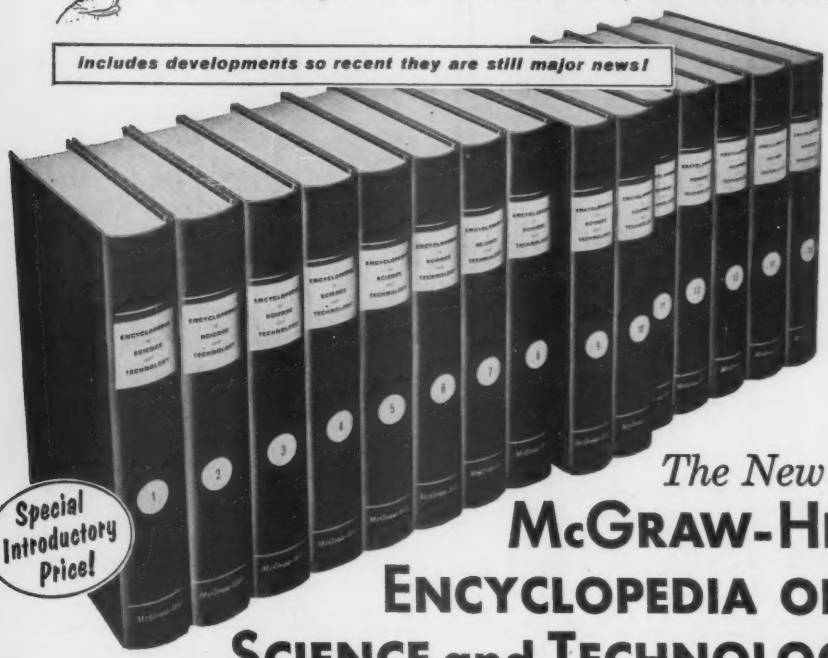

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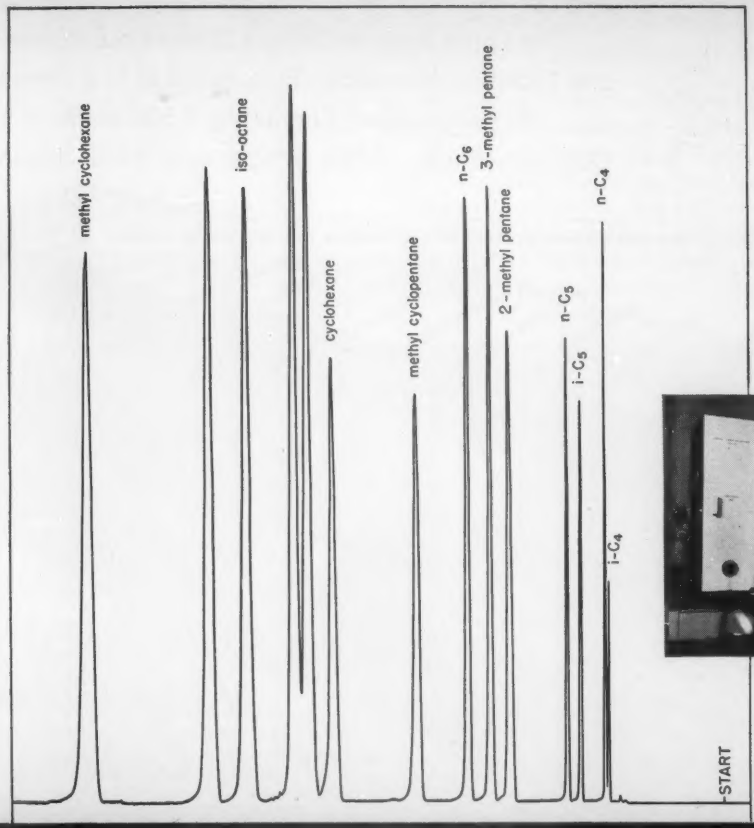
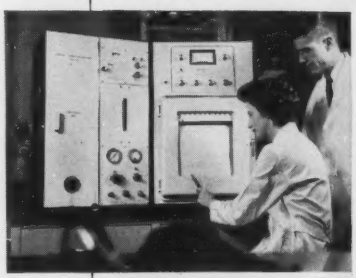


This chromatogram was run on a Model 154-D Vapor Fractometer, utilizing a 150' squalane "U" Golay* column. Detector was of the flame ionization type. The chromatogram displays high-efficiency separation of a number of C_4-C_6 saturated hydrocarbons.

*Patent No. 2,920,478



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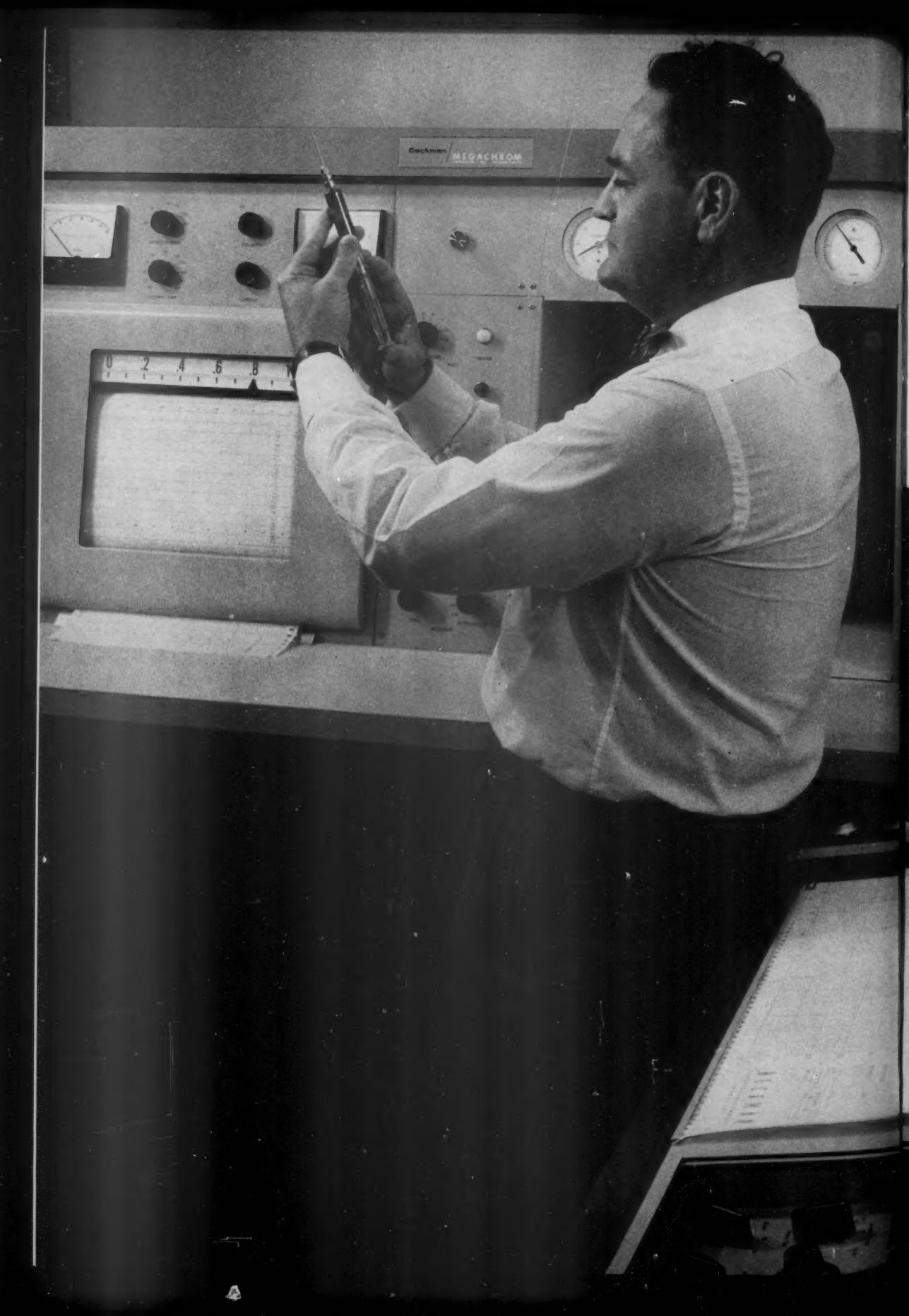
The amphitheater surrounding Rainbow Bridge, Rainbow Bridge National Monument, Utah. See page 519. Photographed by Russell I. Alley, Salt Lake City, Utah. [U.S. Bureau of Reclamation]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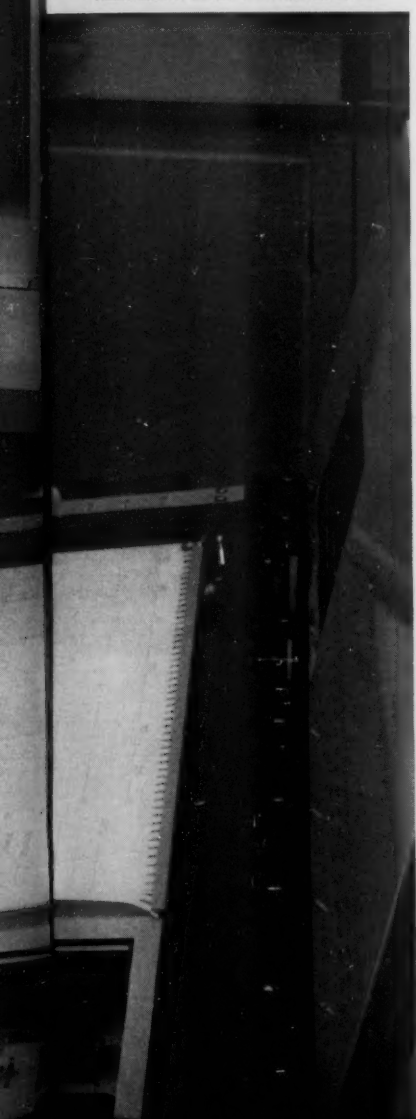
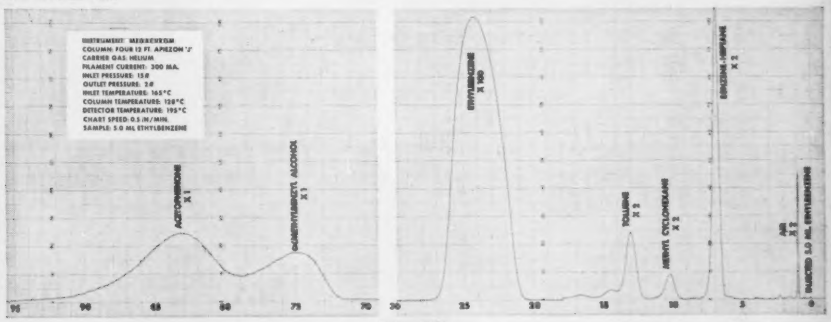
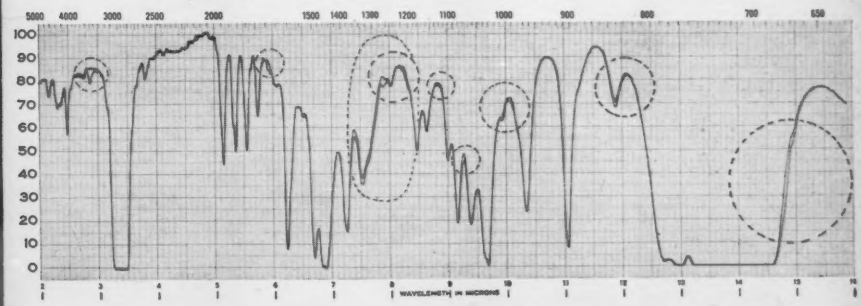
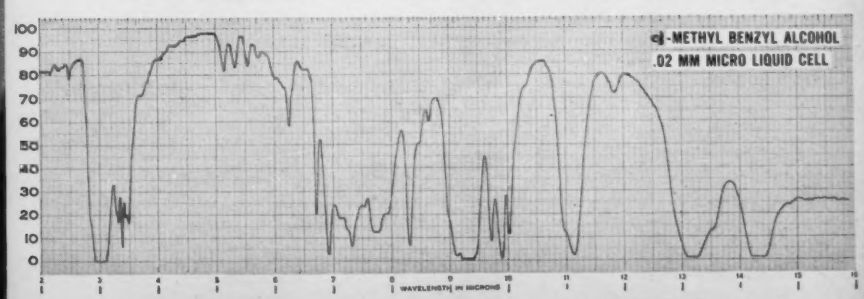




Chromatogram of 5.0 ml. of commercial 99% ethylbenzene fractionated on Megachrom. (Megachrom can handle as much as 20 ml.) Note resolution of contaminants which total only 1% of injected sample.



Infrared spectra of Megachrom-pure ethylbenzene (upper curve) and unpurified commercial ethylbenzene (lower curve). Impurity bands are circled.



Infrared spectrum of 0.1 microliters of α-methyl benzyl alcohol, a contaminant collected by Megachrom. With ordinary chromatograph, collection of this quantity of fraction for infrared or other analysis would be tedious or impossible.

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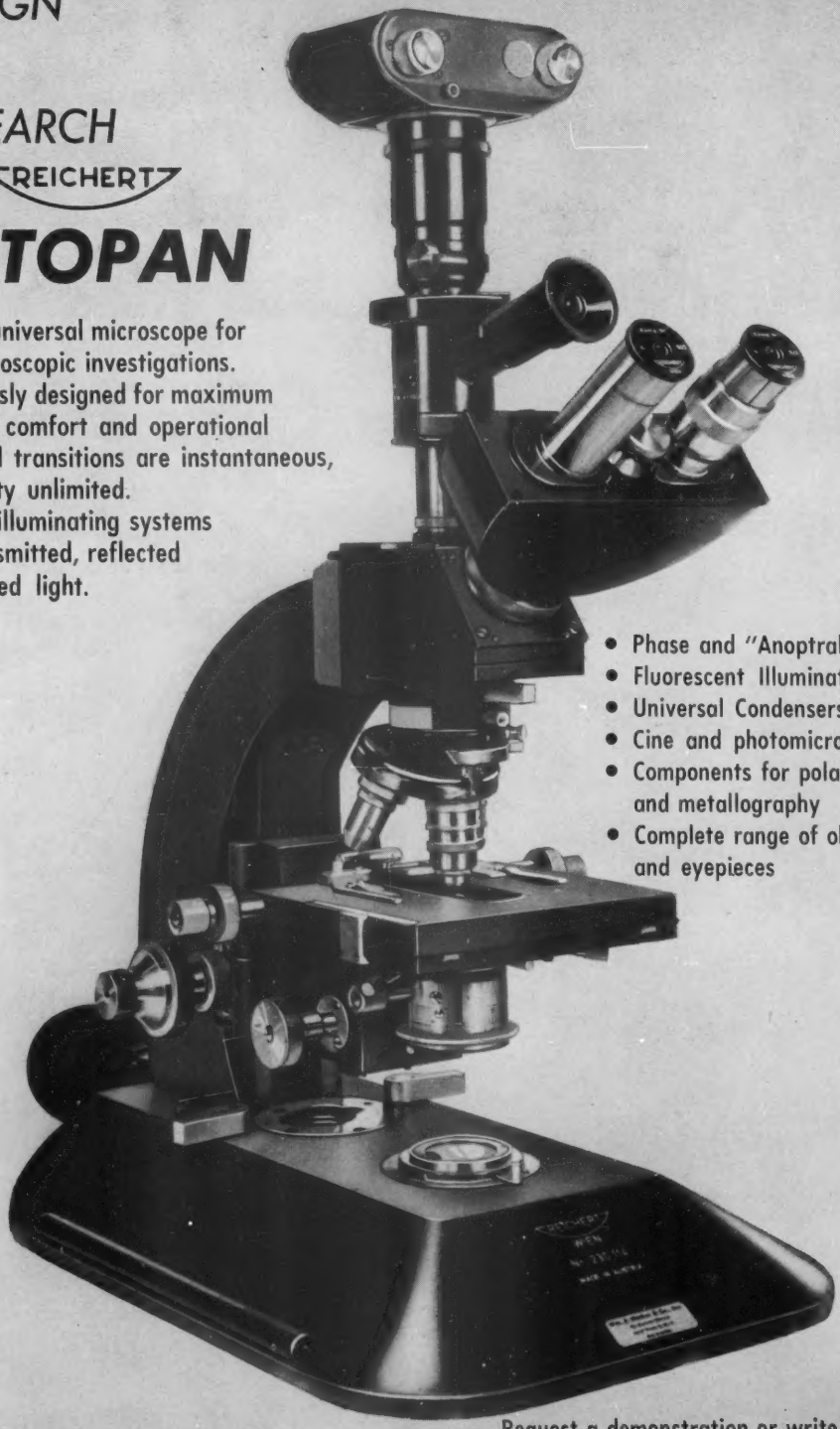

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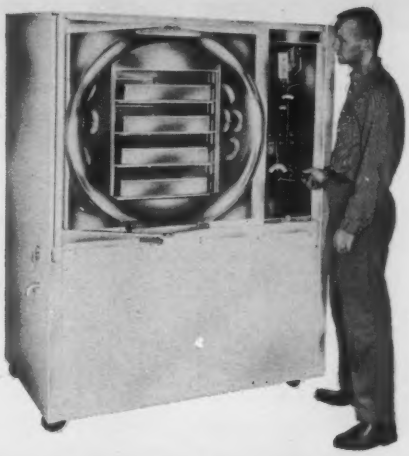

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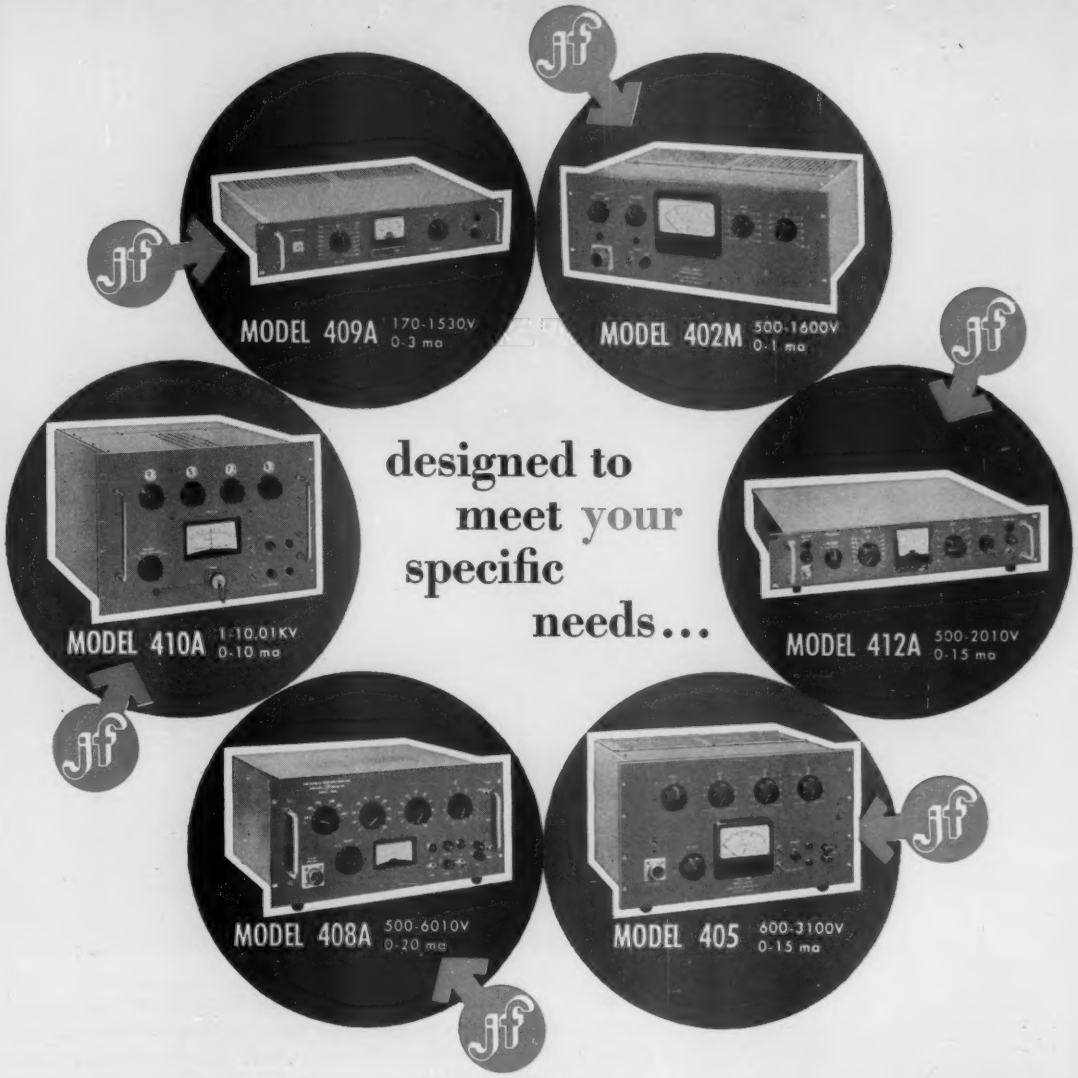
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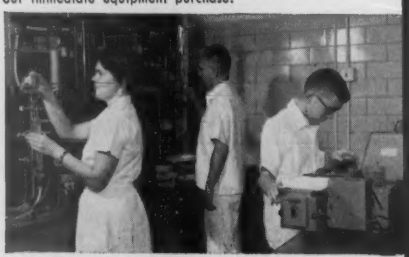

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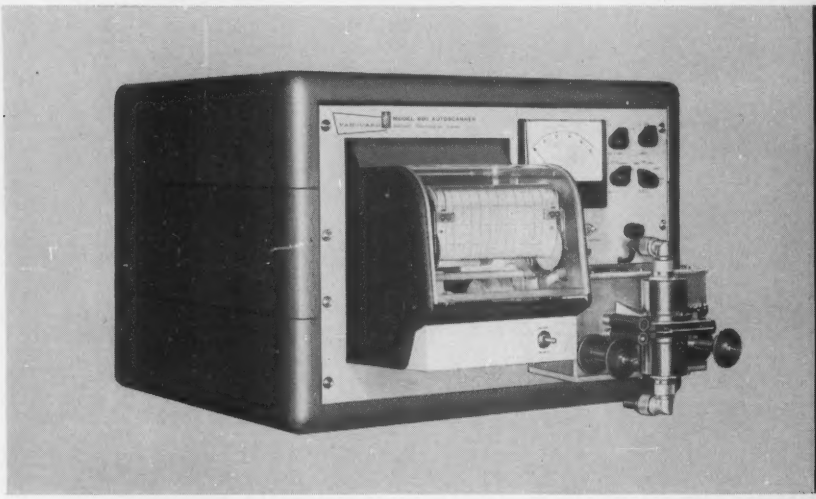

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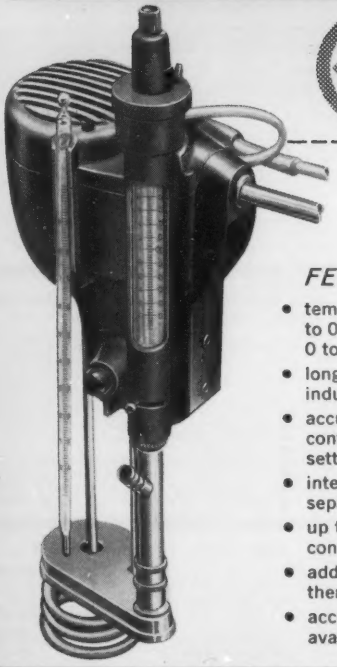

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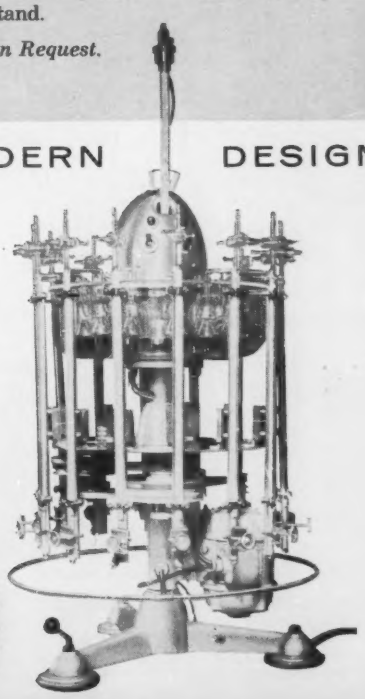

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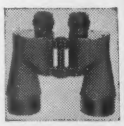

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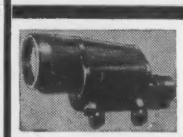

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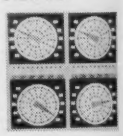

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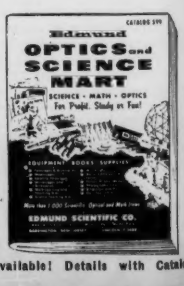

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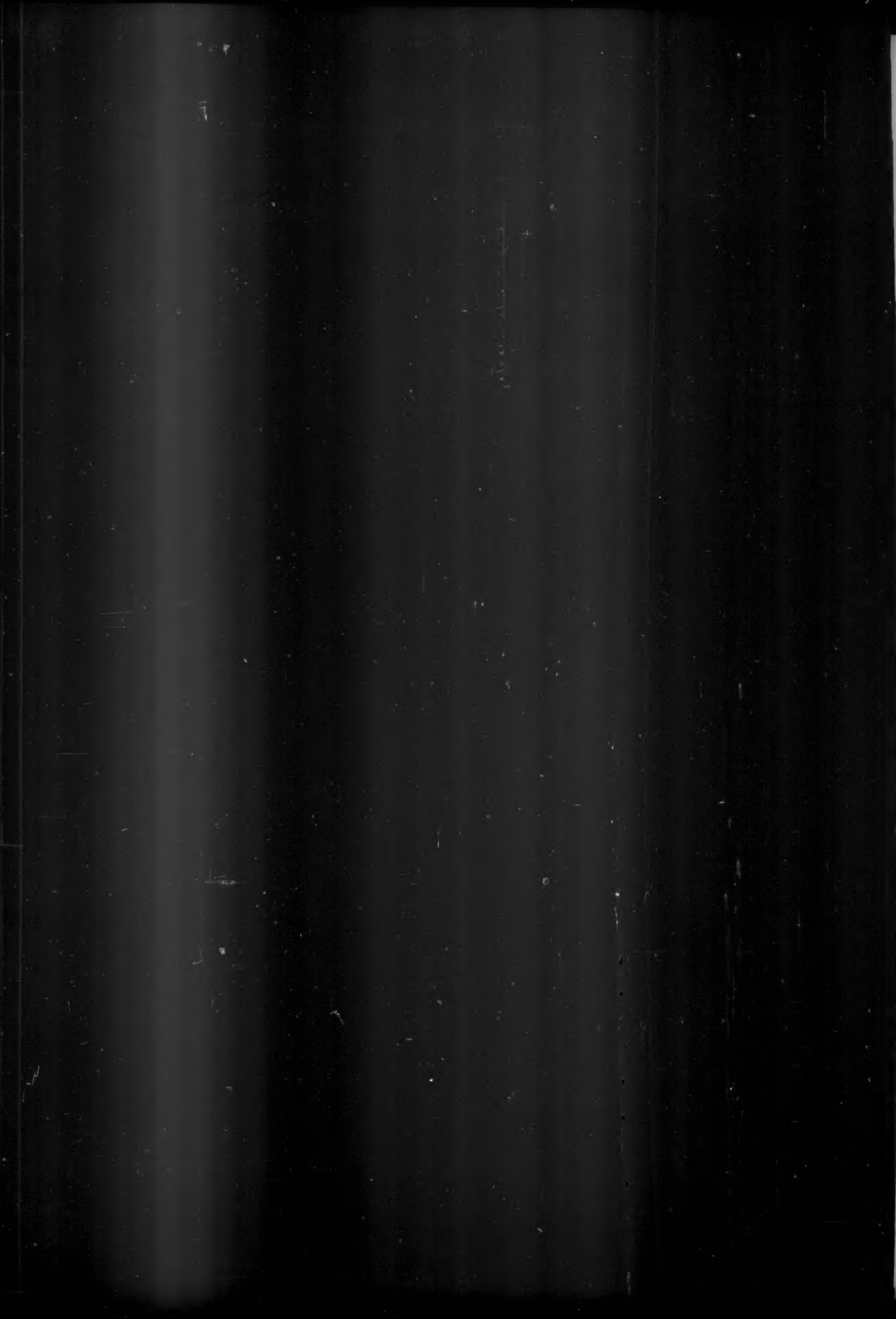

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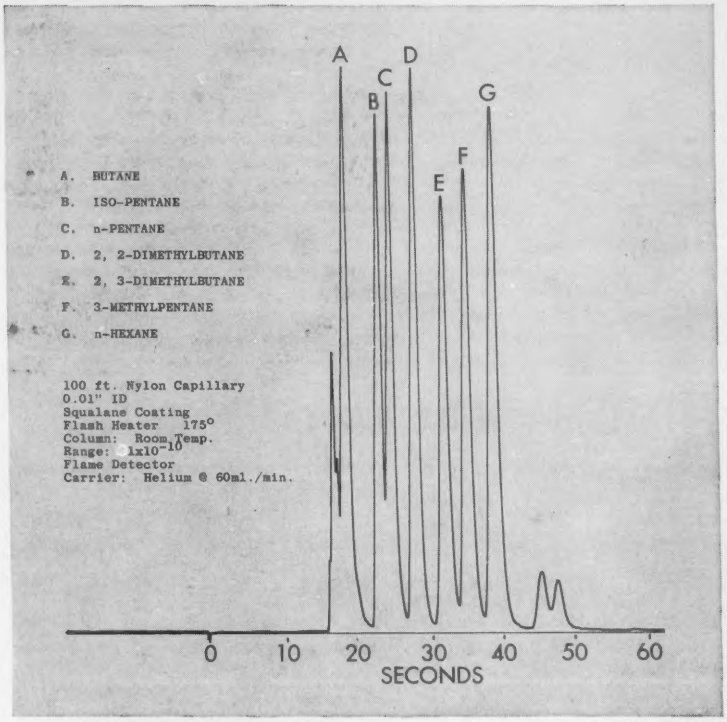
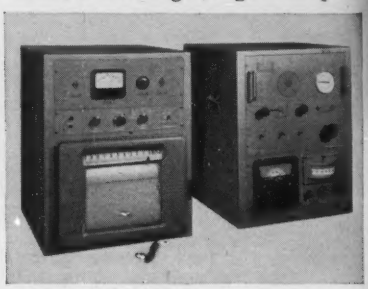
NEW SPLIT-STREAM INLET SYSTEM FOR BARBER-COLMAN GAS CHROMATOGRAPHS



Barber-Colman has now developed a new split-stream inlet system for their Model 20 Gas Chromatograph. Research revealed that ordinary split-stream inlet systems cause fractionation and non-linear splitting under certain conditions. Attempts to obtain quantitative analyses with ordinary splitters sometimes showed the size of the peak non-linear to the sample injected. In addition, a known sample composition varied with the amount of the sample injected. As a result, the new split-stream system became very desirable to eliminate fractionation over a much wider range of sample sizes and boiling points, and to afford more accurate quantitative analyses.

Features of this new linear sample splitter include a carrier gas inlet preheater, and a longer, higher temperature path between the point of liquid sample injection and flow split to the capillary column.



The new system is generally operated in the 250°C to 350°C range. This range vaporizes the liquid sample more rapidly. Gas samples, of course, cause no difficulty to the split-stream system as they are already in the vapor phase.

Typical results with the new splitter in conjunction with a hydrogen flame ionization detector show outstanding linearity without fractionation over a range of sample sizes up to 4.0 microliters. Typical chromatograms illustrate fine quantitative analyses even with short analyses times.

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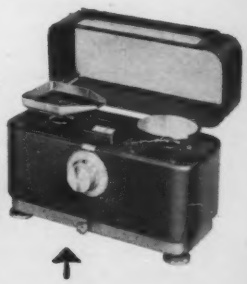
Torsion Laboratory Balance DLT5
Capacity: 500 grams
Readability of Dial: .02 grams

Other Torsion Dial Balances

Model DLT2
Capacity: 120 grams
Readability of Dial: 2 mg.



Model DLT2-1
Same specifications as DLT2 but has scoop for seeds or other bulky material.

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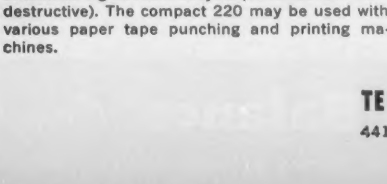

The No. 220 Data Handling Unit — a logical companion to the CN-110, is both a timer and data-handling unit. During the CN-110's accumulation cycle the 220 can be used for true or live timing, then instantly switched to a manual, semi-, or fully-automatic digital readout cycle (destructive or non-destructive). The compact 220 may be used with various paper tape punching and printing machines.

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How Much Research for a Dollar?

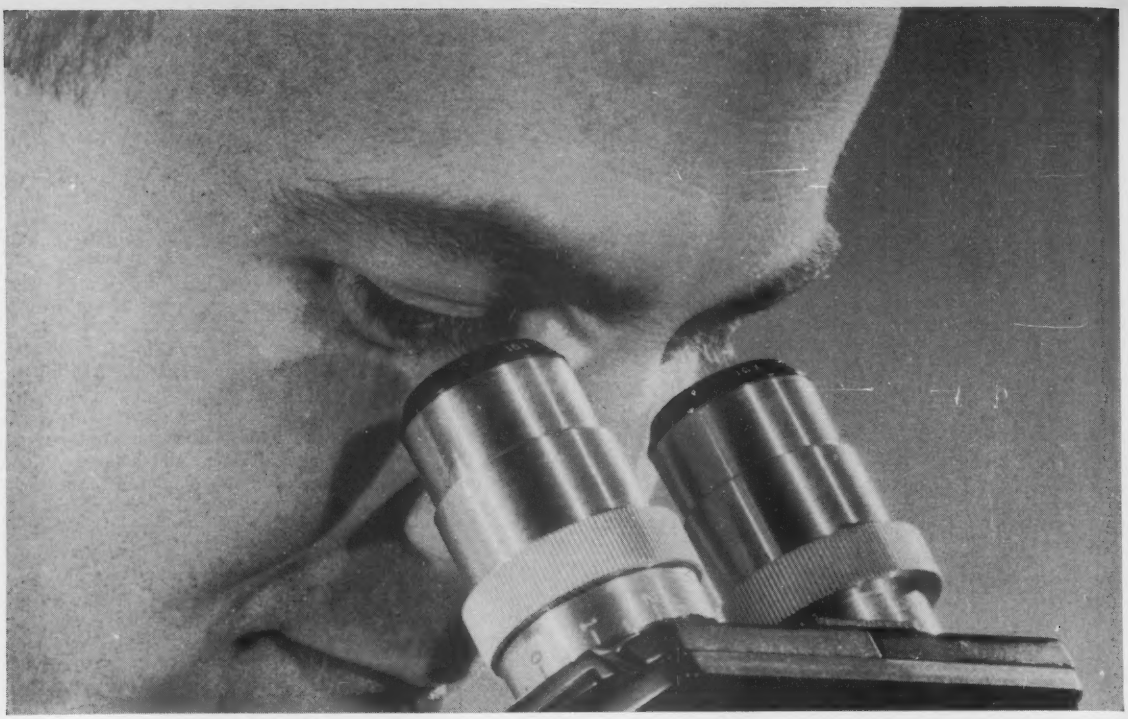
That a dollar will not buy as much now as it would in 1950 is clear to every purchaser who can remember 1950 prices. That the $13 billion the nation will spend on research and development this year will not buy as much equipment or the services of as many scientists and engineers as would the same amount in 1950 is also true, but not so immediately obvious; the figure is so large, the cost elements so varied, and the experience of scientists with figures of this magnitude so meager that one may have to think about the matter to realize that increasing the research and development budget from a little under $3 billion in 1950 to about $13 billion in 1960 does not buy a comparable increase in research and development effort.

Ellis A. Johnson and Helen S. Milton of the Johns Hopkins University Operations Research Office have sought to develop a cost-of-research index that will be useful in analyzing research and development trends. They start with the concept of the cost per year of a technical man; "the 'technical man' is the professional scientist or engineer, together with his supporting technical, administrative, and housekeeping staffs, and his machines and equipment, i.e., the man plus the overhead costs."

Johnson and Milton secured cost records from 17 laboratories, varying greatly in size and roughly equally divided among industry, government, university, and private nonprofit institutions. There was variation in the experience of these laboratories, but there was also a quite useful degree of consistency among their records, sufficient to justify the conclusion that when the costs per technical man were applied to the national research and development totals for the past decade, the result demonstrated that for 4½ times as much money as was spent in 1950 we are getting slightly more than twice as much research and development activity.

Using 1950 as a base year in which the cost-of-research index was 100, the authors report that from 1920 to 1940 the index varied only a few points above or below 50. Between 1940 and 1950 it doubled. Since 1950 the increase has averaged 7 percent a year to bring the index to 191 in 1960. The major elements in the increase have been higher salaries and overhead costs. Professional salaries are going up at about 7 percent a year, overhead costs a little more rapidly, and equipment and material costs not quite so rapidly.

It is always proper to ask whether or not research and development budgets are appropriate to the national needs. Are they increasing too slowly, too rapidly, or at about the right rate? In an ultimate sense this question can be answered only in terms of national needs and the valuation placed upon the work accomplished. Decision on these matters must be in terms of judgment, but a generally accepted cost-of-research index should assist us to reach better informed judgments. For example, Johnson and Milton write, "In military technology . . . there are some critical areas in which the absolute dollar support has increased but in which less actual technical effort is being expended than in 1950." Is this what we want? Surely there are times when a decrease in effort is justified, just as there are times when an increase is mandatory, but we should know what we are doing, and not be fooled by the fact that we are spending more dollars to buy less research. When we are spending $13 billion a year and the amount increases year after year, we need a cost-of-research index just as, for other purposes, we need a cost-of-living index.—D.W.



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26 August 1960, Volume 132, Number 3426 SCIENCE

Protecting Rainbow Bridge

A study of dangers to Rainbow Bridge from water of Glen Canyon Reservoir brings surprising answers.

Angus M. Woodbury

When the Development Program for the Upper Colorado River Basin was passed by Congress, 11 April 1956, conservationist pressure forced inclusion of a provision to "preclude impairment of the Rainbow Bridge National Monument." The same act also established a policy that "no dam or reservoir constructed under the authorization of this act shall be within any national park or monument." In conformity with these provisions, plans have been made by the Bureau of Reclamation and the National Park Service for protecting Rainbow Bridge.

The essence of their proposals is given in Figs. 1 and 2, which show plans superimposed on aerial photographs of the region. Figure 1 gives a general view of the remote and rugged area where this huge bridge is located and indicates the principal points of interest in the proposed program of protection. Figure 2 shows a more detailed view of the area around the monument, including adjacent areas where the protective works designed to prevent impairment of the monument would be located.

In the remarkable erosional setting shown in Fig. 1, the bridge is a mere detail in the rugged landscape, but when approached from the ground by someone coming either up or down Bridge Canyon, in which it is located, it is found to be a tremendous arch with an inside span 278 feet wide and 309 feet high, shown in Fig. 3. It is an integral part of an exceedingly scenic region lying between the 10,000-foot Navajo Mountain and the 3200 foot Colorado River bed in Glen Canyon. The streams draining from the mountain have cut deeply entrenched meandering canyons in the colorful sedimentary rocks, mainly in the spectacular red and white Navajo sandstone through which they flow on the way to the river. This big bridge is a remarkable piece of natural architecture situated in a stupendous setting of cliffs and canyons, in which it is the center of interest (Fig. 4 and cover picture). The Western editor of *National Wildlands News*, J. F. Carithers, says (June 1960), "the country surrounding the national monument is unbelievably spectacular. The great stone arch itself is one of the most inspiring wonders we have ever seen. It is the exclamation point at the end of a beautiful sentence."

The bridge itself has substantial foundations. One end arises from a massive cliff. The other end of the span rests on a broad platform of solid rock. Midway between these two adequate foundation supports is a narrow canyon or inner gorge (indicated in Figs. 3 and 4 but shown in greater detail in Fig. 5). This gorge is sunk about 70 feet into the solid rock, and through it the normally small stream descends rapidly. In times of occasional heavy runoff the stream may become a torrent that leaves its high-water mark along the sides, about 6 to 10 feet above its bed. The projected Glen Canyon Reservoir (Lake Powell) will catch high water and hold it until it is released in a regulated stream through the dam. This will produce irregular fluctuation in the level of the lake and, in turn, induce noticeable fluctuation under the bridge. Without a restraining or barrier dam, the water in Glen Canyon Reservoir would back up the narrow inner gorge under the bridge to a depth of about 46 feet when the reservoir is full. At this level, the water would stand about 24 feet below the top of the inner gorge or about 40 to 50 feet below the bridge abutments and would extend upstream a considerable distance, even beyond the limits of the monument, as shown in Figs. 2 and 6. It has been estimated that the lake would be full 13 percent of the time and that there would be no water under the bridge 23 percent of the time. In order to reach the foundations of the bridge, a wall of water nearly 50 feet high would have to pour over the top of Glen Canyon dam. In fact, the sediment deposited in the inner gorge will actually protect those foundations by reducing erosion in the gorge that would otherwise eventually undermine them. The principal effect of the reservoir in the monument would be the eventual filling of the inner gorge with sediment to the upper level of the reservoir—that is, to within about 25 to 35 feet of the top—one third of the gorge being left unfilled.

Barrier Dam

The proposals for preventing water from backing upstream into the monument are founded primarily upon the idea of constructing a restraining or barrier dam somewhere below the monument. Two sites for such a dam

The author is professor emeritus of biology, division of biological sciences, University of Utah, Salt Lake City.

Fig. 1. Aerial photograph of the region around Rainbow Bridge, looking south up Aztec Creek. The principal features of the plans for protecting the national monument are indicated. [U.S. Bureau of Reclamation]

Fig. 2. A detailed aerial view of the national monument with superimposed outlines of construction planned to protect Rainbow Bridge from damage from the projected Glen Canyon Reservoir (Lake Powell). [U.S. Bureau of Reclamation]

have been studied, one in Bridge Canyon at site *B* (shown in Figs. 1, 2, and 7), located 3200 feet below the monument, and another, much larger site, where construction would be much more expensive, in Forbidden Canyon below the mouth of Bridge Canyon (site *C* in Fig. 1). Site *B* has been selected by the Bureau of Reclamation and the National Park Service as most suitable.

While a barrier dam would keep water of the reservoir from backing upstream into the monument, it would also keep the water from Bridge Canyon from flowing downstream into the reservoir. In order to prevent this water from making a lake on the upper side, it would have to be pumped over the dam. Above this point, drainage from about 7.59 square miles of the steep rough slopes of Navajo Mountain flow into Bridge Canyon, bringing, during snowmelt and summer thunderstorms, torrents of muddy water and flood debris that would settle against the upstream side of the dam. Within a quarter or a half century this sediment would back upstream into the monument.

To alleviate this danger of sediment build-up in the monument, it has been proposed to make a diversion dam above the monument and turn the drainage from 6.54 square miles above this dam through a 0.9-mile tunnel into Aztec Creek. This would divert most of the mud and debris from Bridge Canyon, leaving only the sandy sediment brought by drainage from 1.05 square miles below the diversion dam to accumulate above barrier dam *B*. It is estimated that there is adequate storage for sediment up to the year A.D. 2140.

Fig. 3. Rainbow Bridge, arising from a massive cliff on the right and resting on a broad platform of rock on the left. A partial view of the inner gorge is shown in the center foreground. [U.S. Bureau of Reclamation]

Although construction of a barrier dam at alternate site *C* has been considered, it was excluded from the present proposal. From Fig. 8 it can be seen that this would be a much larger and more expensive dam than one at site *B*. It would require much larger pumping operations and would involve other complicating problems which need not be discussed here.

To build the diversion dam and tunnel and the barrier dam at site *B*, local materials obtained near the sites would be used. Both dams would be earth-and-rock-fill structures. The diversion dam would be 40 feet high, 275 feet long, and 47,000 cubic yards in volume; dam *B* would be 183 feet high, 500 feet long, and 1 million cubic yards in volume.

Obtaining rock from the canyon walls is not difficult, but getting impervious materials for the earth fill in the dams is a serious problem. The only source of such material for dam *B* is on top of a 1200-foot mesa, shown in Figs. 1, 2, and 4. This dirt would have to be lowered from the north end of the narrow neck of the mesa to the dam site. Fortunately there is a feasible route for constructing chutes or conveyor belts for lowering materials and personnel from the mesa top to the dam site. This route is indicated in Fig. 2 and may be seen in Figs. 1 and 4 but is shown in more detail in Fig. 9. The site selected for workmen's camp and construction facilities is located in Bridge Canyon, above the dam.

Material for the diversion dam would come from borrow areas identified in Fig. 2. The builder would have a choice of talus material near the dam or of impervious material from another mesa top. Excavated material from the tunnel would be dumped in Forbidden Canyon, not far from a small area selected as a site for workmen's camp and construction facilities. After completion of the tunnel the excavated material would be hauled back through the tunnel for use in construction of the diversion dam.

Construction Problems

One wonders, on looking at Fig. 1, how the builders of these proposed works would provide access for men, equipment, and supplies in such a remote and rugged area. It would certainly be a difficult and expensive procedure. Three alternate approach routes are under consideration—by air, land, or water. Large cargo-type helicopters may be called into service if the air route is used. Land vehicles could come by road down Forbidden Canyon along Aztec Creek, or up the canyon from the Colorado River, as shown on the map (Fig. 10). For the water route, the use of barges on Lake Powell, after the reservoir has begun to fill, has been considered.

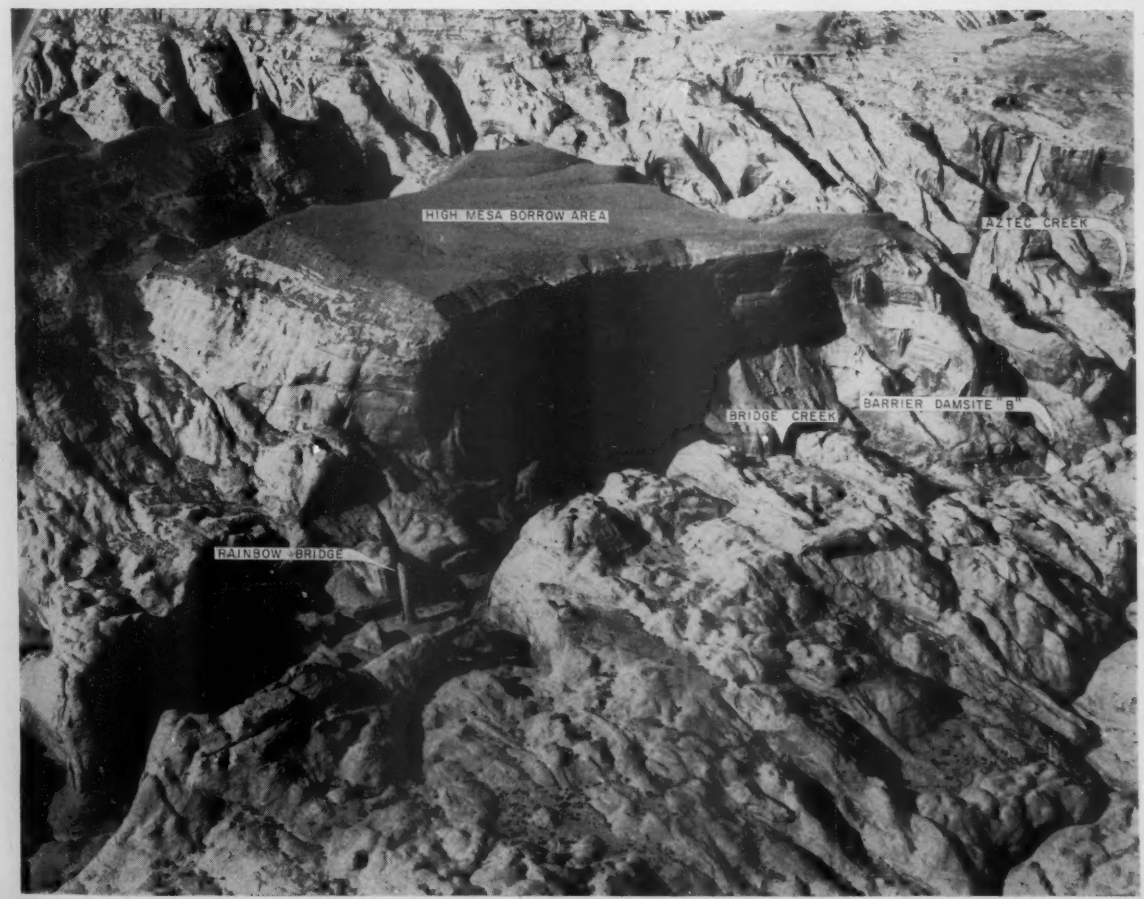
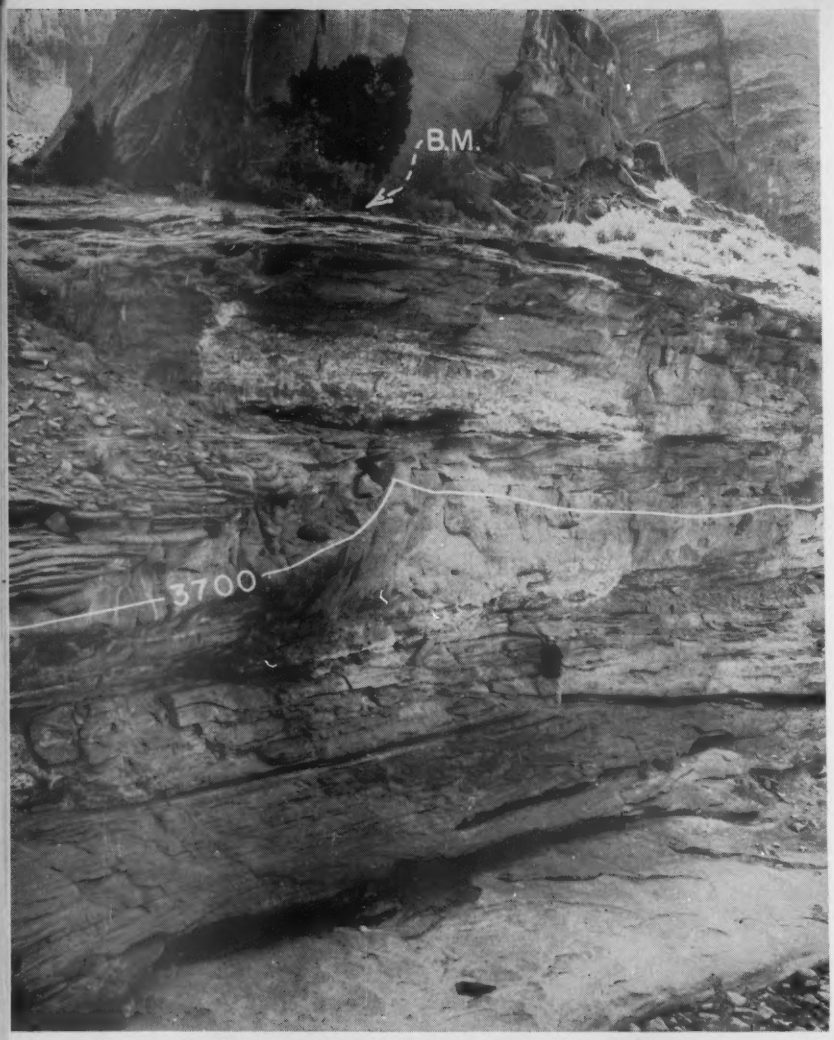
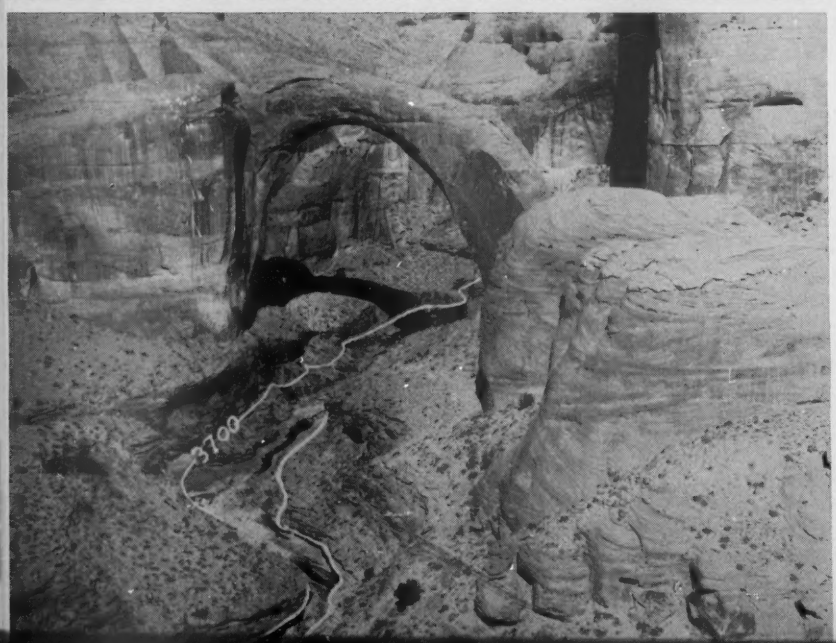


Fig. 4. Rainbow Bridge in its mammoth setting.



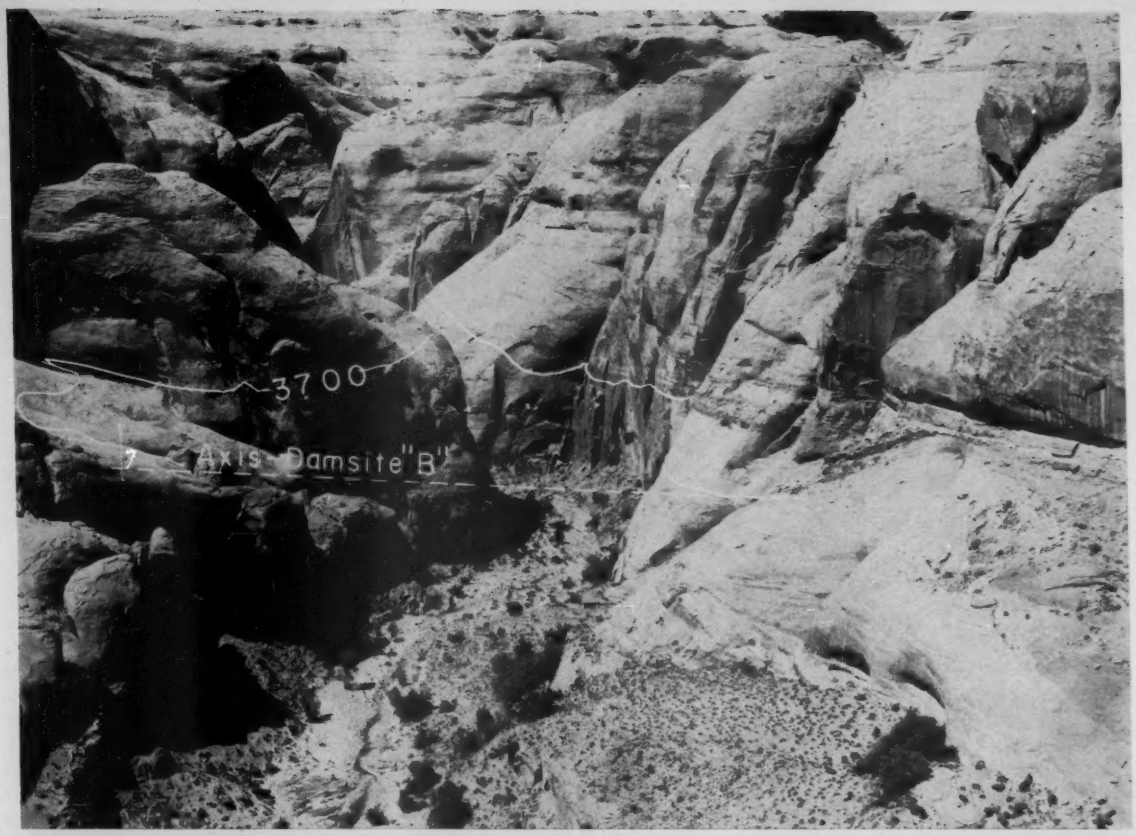


The costs in the case of the first two routes would be enormous. There is a question whether approach by the third route would be within the requirements of the law. The ground route from the south would be approached from Tuba City, Arizona, over 82 miles of rough, unimproved, fair-weather dirt road to the Navajo Indian school at the base of Navajo Mountain near the Utah-Arizona border; from there about 22 miles of new road would have to be made through fantastically rough country (Fig. 1, top center).

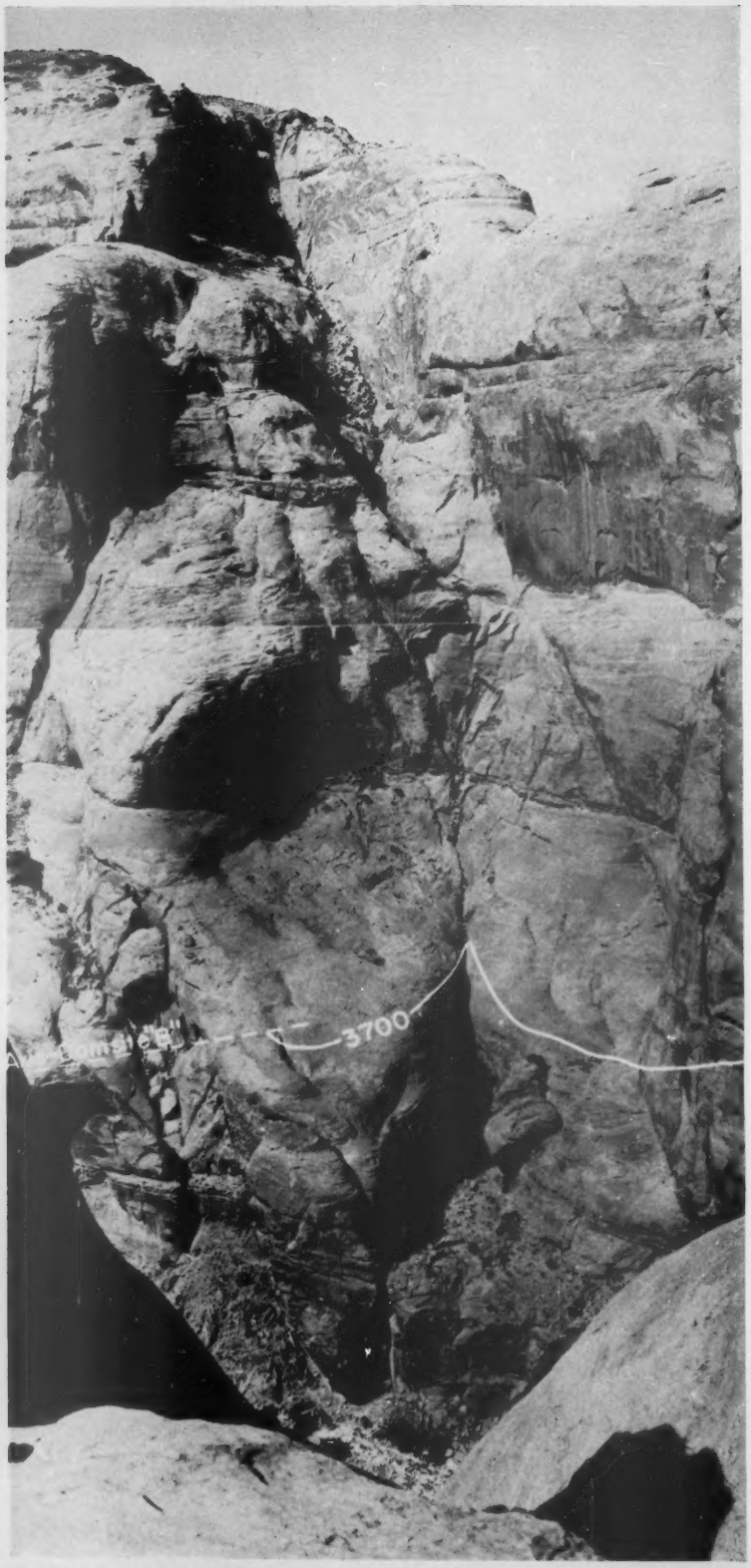
The road from the Colorado River would have to follow Aztec and Bridge creeks for almost 10 miles through terrain which is peculiarly difficult for road making. Figure 11 shows a particularly narrow and twisting section along lower Aztec Creek where there is no room for a road and where much of the road would have to be cut into the cliff face. Some of the turns in the canyon would be too sharp for certain types of large vehicles and equipment, and tunnels would be required. After dead-water storage was started in Glen Canyon, this road would be under water almost to dam site *B*; thus, it would have to be used before that time.

To reach the mouth of Aztec Creek would require a bridge or ferry across the Colorado River and new access roads on the northwest side of the stream. Here there are two possible routes—one from the Glen Canyon dam site and one from Escalante, Utah. The first would require about 115 miles of new road through exceedingly rugged terrain—a project too expensive to contemplate. As for the second route, about 65 miles of rough, unimproved, fair-weather road now extends from Escalante to "Hole-in-the-Rock," on top of the cliff rim above the river; about 27 miles of new road would be required to get down through the cliffs to reach the river opposite the mouth of Aztec Creek.

Fig. 5 (top left). A close-up view of the north wall of the inner gorge, showing the height to which water from the reservoir would back up in the gorge if it were not restrained. The north base of the arch, resting on a broad platform of rock, is shown at top. Fig. 6 (bottom left). A view of Rainbow Bridge looking downstream, showing the prospective high-water mark when the reservoir was full. Fig. 7 (top right). A view of barrier dam site *B*, looking downstream, showing the prospective high-water mark. Fig. 8 (bottom right). View of barrier dam site *C*. [U.S. Bureau of Reclamation]


3700'
Axis Damsite "B"

Axis Damsite "C"



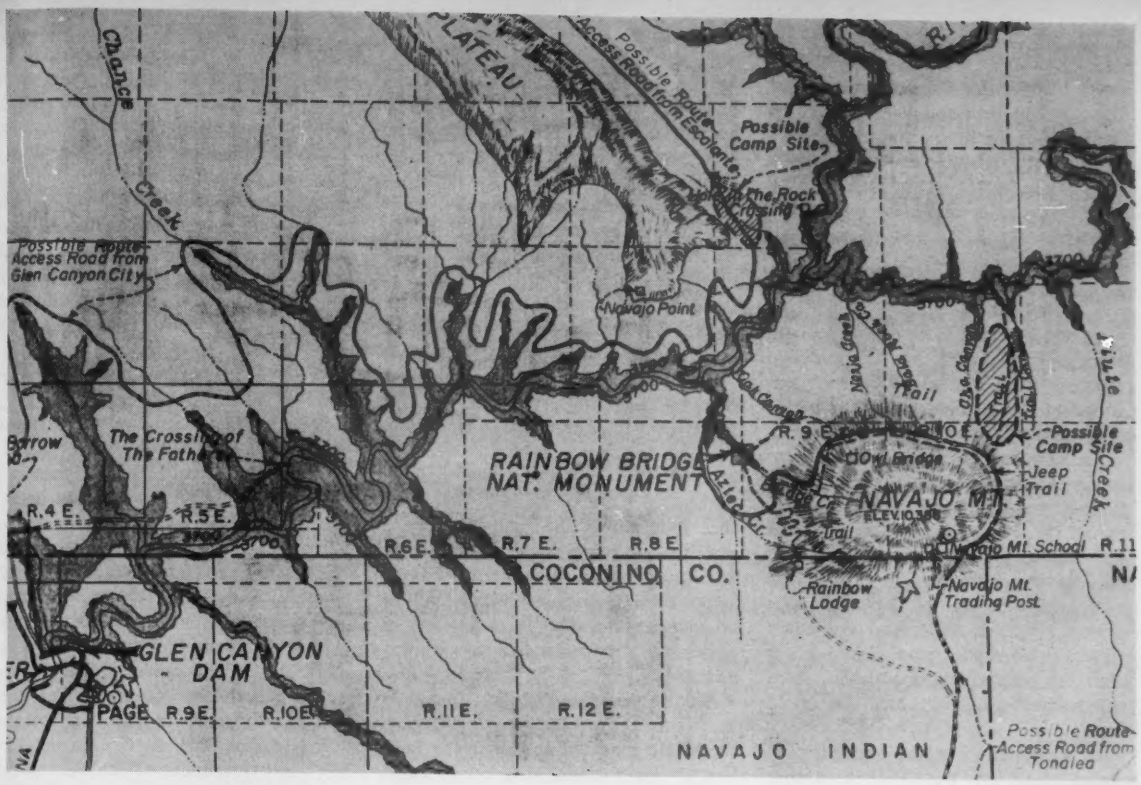
The Alternative

If no protecting works are built, the water, as the reservoir filled, would gradually back up into the monument and pass under the bridge and up the canyon, even beyond the monument. If muddy, silt-laden floods or high water from Bridge Canyon entered the reservoir, the coarse sediment would be deposited where the force of the current was checked after it entered the clear water of the lake. When the reservoir was full, the sediment would be deposited in the canyon, mainly in the narrow gorge above the bridge. As the water level fluctuated in the reservoir, the sediment would tend to be pushed toward the lower water levels farther down in Bridge Canyon, where a delta would gradually accumulate.

In succeeding years, the delta thus formed would slowly grow up Bridge Canyon until, given time and sediment enough, the inner gorge under the bridge would be filled by the delta to the highest level of the reservoir. At this stage of development, probably 50 to 100 or even more years in the future, there would be no water under the bridge. Instead, the small stream would wind through the narrow gorge on top of the sediment, bordered by heavy stands of stream-side vegetation, probably willows and tamarix that would grow there naturally except where the stream kept the channel clear.

During the period when the inner gorge was filling with sediment there would be a zone of fluctuation within that gorge, where the water level would rise and fall. Visitors to the bridge during this period might notice, at times when the lake was not full, a high-water mark at the 3700-foot level and a zone of sediment in the bottom, denuded of vegetation. There might be some unattractive areas during the early stages of sediment deposition, but these would be covered as the inner gorge

Fig. 9 (left). The route over which materials from the mesa top would be lowered to dam site *B*; disfiguring scars would be left on the face of the cliff. [U.S. Bureau of Reclamation] Fig. 10 (top right). Map showing alternative possible routes of access roads to Bridge Canyon protective works. [University of Utah] Fig. 11 (bottom right). A narrow winding section of Forbidden Canyon, along lower Aztec Creek, where road-building would be difficult. [U.S. Bureau of Reclamation]


Chance Creek
PLATEAU
Possible Route Access Road from Escalante
Possible Camp Site
The Rock Crossing
Possible Route Access Road from Glen Canyon City
Navajo Point
Navajo Creek
Trail
Oak Canyon
Owl Canyon
Possible Camp Site
Jeep Trail
The Crossing of The Fathers
RAINBOW BRIDGE NAT. MONUMENT
NAVAJO MT.
ELEV. 10,388
Trail
Navajo Mt. School
Rainbow Lodge
Navajo Mt. Trading Post
R.4 E.
R.5 E.
R.6 E.
R.7 E.
R.8 E.
COCONINO CO.
GLEN CANYON DAM
PAGE
R.9 E.
R.10 E.
R.11 E.
R.12 E.
NAVAJO INDIAN
Possible Route Access Road from Tonalea

filled. When that happy time arrived, there would be nothing about the appearance of the little brook meandering through the stream-side vegetation to remind the visitor of the former presence of the reservoir in the monument.

The Dilemma

A real dilemma is posed for all concerned. In order to treat this problem objectively as a matter of total conservation, the bridge and its setting in the spectacular canyons must be considered together, regardless of how much of the area is actually included in the national monument. From the air, the whole area is a scenic marvel, and the mammoth bridge is hard to find because its size is insignificant as compared with that of the stupendous setting (Figs. 1, 2, 4, and the cover picture). No matter who administers it after the reservoir is established, there will be public concern over the whole area.

In considering the whole magnificent region, here are the alternatives that must be faced. Should the present law be enforced and adjacent scenic features be permanently scarred and injured in order to protect one small but important sector of the over-all scenic features? Or, to set it in another frame of reference, which would be preferable: (i) backing water up the inner gorge under the bridge and gradually filling the gorge with sandy sediment for about two-thirds of its 70-foot depth without in any way affecting the bridge itself, or (ii) permanently marring the natural scenic beauties of the region, including both approaches to the bridge, making it impossible for anyone to reach the central scenic attraction without passing these unnatural and distracting "protective" works?

To restate it in still another way: To do nothing would allow the area to heal itself naturally within a century and leave no scars; to build the protective works would entail permanently marring the remarkable landscape, not only with the dams and tunnels but also with the construction and equipment accessory to the main work, such as excavations on mesa tops and talus slope, cables, belts or roadways for transporting materials to the dam sites, equipment sheds and camp sites, and accessory roads cut into the faces of narrow canyons. The second alternative, in short, would entail doing exactly what conservationists are trying to avoid—bringing the jarring and marring scars of construction activities into stupendous natural landscapes. In addition, it would require a fantastic investment, estimated to range from $15 to $25 million, and a continuing annual maintenance expenditure.

It is obvious from these comparisons that building the protective works is not a good solution to the dilemma, but conservationists may hold that the principle of protecting the national parks and monuments is at stake and that it is worth the cost in order to preserve the principle. And so it might be if there were not another and better solution to the problem which requires no sacrifice of principle and which requires no change in the present protective law.

This alternative solution must be based upon the concept of protecting the whole area and not alone the Rainbow Bridge National Monument. I here propose that a plan be developed to include the remarkable scenic region adjacent to the monument in a national recreation area to be administered by the National Park Service. It is just as important to protect this surrounding area from desecration as it is to protect the monument. Progress is already being made in this direction. The National Park Service is now preparing a master plan for a Glen Canyon National Recreation Area similar to that now in effect at Lake Mead. The proposed recreation area includes the entire shoreline of the reservoir, 1830 miles in length, and some other, adjacent areas. The area surrounding the Rainbow Bridge might well be included.

By incorporating the monument in the proposed recreation area, the National Park Service would be relieved of treating the two as separate projects and could administer them as a single unit, with a suitable policy for the whole area. The Park Service would then be able to determine what should be done. It is not likely that the answer would be defacement of major features of the landscape.

This is a case which calls for conservationists to do a little soul searching. The fallacy of joining a crusade without a realistic appraisal of the facts should be obvious by this time. It is a fact that the presence of the Glen Canyon Reservoir will open up to the general public, by way of boating on Lake Powell, a thousand enchanting nooks, glens, and alcoves in the tributaries that lead into Glen Canyon, many of which are practically inaccessible without the lake. It will open the vast scenic resources of the interior of the rough country of the Southwest to regulated use under the control of the National Park Service.

Conservationists recognize that in a world faced with a "population bomb" there is as great a need to conserve water for the arid lands of the earth as there is to conserve scenic landscapes. They also realize that there are many other resources that should be conserved and that the relative values must be weighed carefully. They should support both the movement for conservation of water in Glen Canyon and the National Park Service in developing the by-products of the lake as national recreational resources. In addition to opportunities for boating, fishing, photography, and the like, construction of the lake will provide access to areas of magnificent scenery, and all these opportunities are bound to be appreciated in the years to come.

As the years pass into centuries, deltas at the mouths of incoming streams will help to fill the reservoir with sediment. Long before it is completely filled, the lengthening deltas may be used for some purpose or other. What use will be made of these newly made lands remains for the future to decide. If they are maintained as parts of national recreation areas, they may well serve as centers from which visitors can explore the thousand side canyons and scenic attractions that radiate from the main Glen Canyon. Without any barrier dams in Bridge Canyon, Rainbow Bridge would be as accessible as any of the other scenic marvels of the Glen Canyon tributaries.

The major objective of sincere conservationists is to leave the people of the future with a heritage of wisely used resources which will continue to serve mankind through many additional generations.

Direct Metabolic Interactions between Animal Cells

Their role in tissue function and development is reconsidered.

Heinz Herrmann

Multitudinous forms of cellular interaction are among the basic prerequisites for the continuity of life. The life cycle of unicellular organisms, like bacteria, depends upon a wide range of saprophytic and epiphytic relations, and sexual reproduction in protoza is initiated by mating reactions which are determined by specific molecular patterns in the surfaces of interacting cells (*1*). Some organisms, like slime molds, exist during part of their life cycle in a unicellular state, in another part of their life cycle in a multicellular state. The transition from the former to the latter state involves a definite pattern of cell interactions which results in cell aggregation and the subsequent differentiation of the cells in the aggregate (*2*).

The evolutionary appearance of strictly multicellular organisms can be considered an elaboration and consolidation of protistan forms of cell interactions. An obvious aspect of cell interactions in multicellular organisms is the continued contact between cell surfaces (*3*). This phase of cell interaction is being investigated by electron-microscopic analysis of cell boundaries and of basal cell membranes (*4*), by the study of adhesion (*5*) and of aggregation and disaggregation of cells (*6*), and by the study of the behavior of cells in tissue culture (*7*). A molecular basis for the interaction of cell surfaces has been considered (*8*).

Particular importance has been attributed to the role of direct cell interactions in the process of embryonic development. Actually, the bulk of the work carried out in experimental embryology consists of attempts to demonstrate the appearance of morphological changes in one cell type in response to the presence of another cell type under a variety of in vitro and in vivo conditions. In recent years much ingenuity has been applied in work with systems of embryonic tissues in which characteristic forms of cell interaction can be demonstrated experimentally (*9*, *10*). Much can be gained in this work with embryonic tissues, since the cell interactions which occur during embryonic development constitute one of the ways in which the genetic inventory of the primitive embryonic cell comes to expression and determines the appearance of certain cell properties which are characteristic for the fully developed cell.

Although some advance has been made in understanding the nature of the changes that occur during and subsequent to cell interaction, little consideration has been given to the relation of the observed structural changes to alterations in the metabolic pathways during cell interactions. One exception is perhaps the analysis of fertilization in the sea urchin. How much of the information obtained in this instance is applicable to cell interactions in general is uncertain.

It is proposed in this article to discuss briefly two types of drastic metabolic readjustments which are part of the interaction of animal cells and to consider some of the implications of these findings. Interaction is essential in one case for the functional activity of the interacting cells; in the other case, for maintenance of metabolic synthesis.

The author is professor of zoology at the University of Connecticut, Storrs.

Metabolic Interaction and Specific Function

The bulk of the evidence for functionally significant metabolic interactions between cells is derived from work, carried out about 20 years ago, on the production of fluid in the brain by the chorioplexus (*11*) and the formation of aqueous humor in the eye by the ciliary body (*12*) These histologically heavily folded tissues consist of a single and double layer, respectively, of closely packed cuboidal epithelial cells which cover a loose mesodermal connective tissue, the stroma, in which the cells are separated from each other and from the epithelial layer by collagen fibers and a ground substance (Fig. 1). In surviving segments of these tissues it was found that the epithelia showed strongly positive oxidation-reduction potentials and the stromata, strongly negative oxidation-reduction potentials when tested with a large series of oxidation-reduction indicators with closely spaced potentials. Under anaerobiosis, or in the presence of sodium cyanide, the epithelium acquired a strongly negative oxidation-reduction potential. This indicated the dependence of the positive values for oxidation-reduction potentials on oxidative enzyme systems in this tissue component. The stroma was assumed to be the site of dehydrogenases catalyzing reactions with strongly negative potential and to be devoid of oxidative enzymes such as cytochrome oxidase. A mechanical separation of the epithelial and stromal cells in these tissues and manometric determinations of enzyme activities in the two tissue components confirmed this interpretation of the results obtained with the oxidation-reduction indicators (*13*).

The functional significance of the differences in oxidation-reduction potential became apparent from two lines of evidence. In the embryonic chorioplexus, no potential difference was found between epithelium and stroma before the onset of functional activity (*14*). The potential difference and the production of cerebrospinal fluid became established at the same stage of fetal life. Also, in the fetal kidney analogous changes in the cytochrome-oxidase activity in the tissue components were observed with the beginning of functional activity (*15*). In another series of experiments a shift in the potential differences of the ciliary body

was observed in scorbutic guinea pigs (*16*).

The appearance of differences in oxidation-reduction potential during embryonic development was brought about by an increasing concentration of oxidative enzyme systems in the epithelia of these tissues and the maintenance of negligibly low concentrations of oxidases in the stromata. The shift in the potentials in the scorbutic animals was explained by a break in the metabolic interaction of the epithelium and stroma. It was proposed that ascorbic acid is an essential mediator in the electron transport from the epithelium to the stroma and that its absence in a deficient organism leads to an interruption of the electron flow from one tissue component to the other.

From these experiments it was concluded that the undisturbed maintenance of the potential differences in the epithelium and stroma of the ciliary body, of the chorioplexus, and also of the kidney is essential for the functional activity of the tissue. The metabolic maintenance of these potential differences generates a flow of electrons from the stroma to the epithelium and becomes a source of energy for transport of fluid or of ions between these tissues. In this sense the maintenance of the potential difference is essential for the continuation of the function of these tissues.

It should be pointed out that more than metabolic oxidation-reduction reactions can be involved in tissue interactions. Two adjacent tissue components may also participate in functionally important metabolic transformations of specific molecular cell constituents. Such a case is the cycle of visual pigment in the retina, in which both the neural epithelium and the pigment epithelium participate (*17*).

Dependence of Mesodermal Syntheses on Epithelial Metabolism in the Cornea

In the cornea, a more systematic quantitative study of intercellular metabolic reactions is made possible by the ease with which stroma and epithelium can be mechanically separated. This is due to the smoothness of the boundary between the two tissue components over a large part of the corneal area (Fig. 1). As in the tissues mentioned above, the enzyme activities involved in the terminal metabolic oxidations were found in the epithelium. High rates of glucose utilization and lactic acid formation were found in both the epithelium and the stroma (*18*). In following the changes in the lactic acid level, it was observed that the lactic acid in the stroma decreased much more slowly in the absence of epithelium then it did when epithelium was present. It was concluded that a part of the lactate which is formed in the stroma is oxidized in the epithelium. Thus, it seemed that the stroma supplied a substrate for enzymatic oxidations in the epithelium.

For a long time the question of whether the stroma benefits in any way from supplying raw materials for oxidative processes in the epithelium remained unexplored. Within the last two years, however, evidence has accumulated that two, and perhaps three, synthetic processes in the corneal mesoderm are greatly reduced if the epithelium is removed from its close juxtaposition to the stroma. The following syntheses in the stroma were found to be affected by the removal of the epithelium: (i) the incorporation of glycine-1-C^{14} into the collagen fraction (*19*); (ii) The incorporation of S^{35} into the mucopolysaccharides of the ground substance (*20*); and tentatively, (iii) the uptake of thymidine-C^{14} into the hot trichloroacetic acid extracts (deoxyribonucleic acid) of the stroma (*21*). This apparently means that metabolic processes in the epithelium can substitute for incomplete metabolic pathways in the stroma and that in this manner the epithelium can maintain synthesis of macromolecules in the stroma.

Mechanism of the Epithelial Effect

Investigations carried out so far provide only tenuous clues as to the nature of the interaction between the epithelium and the stroma. Addition of a homogenate or a mince of the corneal epithelium, of other chick organs such as liver, heart, or kidney, or of adenosine triphosphate to the incubation mixture used in incorporation measurements was found to be ineffective as a source of energy for restoration of synthetic activity in the stroma after removal of the epithelium (*22*).

Such experiments make it doubtful that diffusible metabolic intermediaries such as high-energy phosphate esters or coenzymes serve as links in the transmission of metabolic energy from the one to the other tissue component. These doubts are strengthened by autoradiography of corneal sections incubated with C^{14}-labeled glycine solution after removal of one half of the epithelial cover of the stroma (*23*). Such preparations show that incorporation into the stroma follows a sharp boundary which coincides exactly with the termination of the epithelial cover of the stroma. The abruptness of this boundary is not compatible with an assumed diffusion gradient. Therefore, one can ask whether the transmission of metabolic energy from the epithelium to the stroma follows some structural component of the stroma—for example, protein-sulfhydryl groups—or whether it involves small molecular compounds (perhaps ascorbic acid) which are bound to some structural elements of the mesodermal matrix. In this connection it should be pointed out that several systems involving protein-sulfhydryl groups and bound water for electron transport over a distance have been suggested recently (*24*). The role of sulfhydral groups as terminal acceptors for electron transfer from mitochondria to the bacterial cell wall has been investigated by Falcone and Nickerson (*25*).

Attempts were made to distinguish, by the use of metabolic inhibitors, between metabolic pathways supporting syntheses in the epithelium and in the stroma, respectively. Although these experiments have not led to conclusive results as yet, differences between the effects of some metabolic inhibitors on protein synthesis in the stroma and in the epithelium seem to indicate differences in these pathways (*26*). At the same time, analysis of changes in the metabolic systems in the stroma in the absence of the epithelium are being carried out in order to obtain more direct information about those metabolic reactions in the stroma which are dependent upon the epithelium and about the pathways of energy transfer from the epithelium to the stroma.

The cornea may be a model system for the exploration of mechanisms of certain metabolic cell interactions since it seems to be the first tissue in which a dependence of protein synthesis on tissue interaction can be observed. The main advantages of this system for a far-reaching analysis of such metabolic interactions are its accessibility *in situ*; the ease of preparation of the two tissue components, which can be used to obtain quantitative information about the effect of the epithelium on the stroma;

the viability of the cornea *in vitro*, the homogeneity of the cell populations in the separable tissue components; and the specificity of the cell products synthesized in the stroma (collagen, keratosulfate).

Role of Metabolic Tissue Interactions in Developmental Processes

The importance of the metabolic tissue interactions which are necessary for the function of these tissues is evident. It remains to define the possible significance of the metabolic tissue interactions which maintain synthetic processes in one or in both of the involved tissue components. The studies on the cornea call attention to the role which metabolic tissue interactions may play in the course of embryonic development.

The dependence of the corneal stroma upon the epithelium has been observed on the eighth day of development of the chick embryo (*27*). This is only two days after the onset of cell migration from the head mesenchyme into the corneal area. Therefore, it is evident that protein synthesis and, consequently, growth of the corneal stroma early become dependent on the supply of epithelial metabolic energy. In contrast, the stationary cells of the head mesenchyme, which form the sclera, develop their own enzymatic mechanisms for production of the energy needed for synthetic processes. As a consequence, the scleral mesoderm can grow autonomously.

Even before differentiation of the corneal and scleral mesoderm takes place, the head mesenchyme must produce enough energy to support the syntheses required for proliferative growth. The apparent loss of this autonomy in the mesenchymal cells which become corneal mesoderm can come about through one or both of the following changes.

1) The total energy output of a primitive mesenchyme cell may be sufficient to support the synthetic activities connected with the growth and differentiation of these undifferentiated cells into corneal mesoderm. In this case, the necessity for a supply of energy from the epithelium for synthesis would mean that some of the energy produced in these differentiating cells is diverted into functional channels such as movement of fluid. A scheme for this type of distribution of energy consumption for functional or growth processes has recently been discussed by Rutter (*28*).

2) The need for an epithelial energy supply to the stroma could also mean that the enzyme systems generating energy deteriorate to some extent as the head mesenchyme differentiates into the corneal mesoderm. Such a loss is apparent from the results of Kuhlman and Resnik (*29*). These authors found that in new-born rats the isocitric dehydrogenase and glucose-6-phosphate dehydrogenase activities in the corneal epithelium increased sharply, while the corresponding enzymatic activities in the stroma declined with development. Other examples of protein loss during differentiation are the disappearance of heart myosin from parts of the blastoderm (*30*) and of proteins for the formation of tryptophan peroxidase in the embryonic gut (*31*).

The scleral and corneal mesoderm differentiate not only with respect to autonomy or dependence of their energy supply but also with respect to the type of mucopolysaccharide produced. In the nontransparent sclera of the chick, cartilage is formed with chondroitin sulfate as the main constituent. In the cornea is found a mucopolysaccharide mixture in which keratosulfate is prevalent. Chondroitin sulfate contains galactosamine, glucuronic acid, and sulfate, while keratosulfate is made up of glucosamine, galactose, and sulfate but no uronic acid. It will be of interest to investigate whether the same differences in the metabolic pathways which support syntheses in the cornea and sclera, respectively, also control the types of mucopolysaccharides which are formed

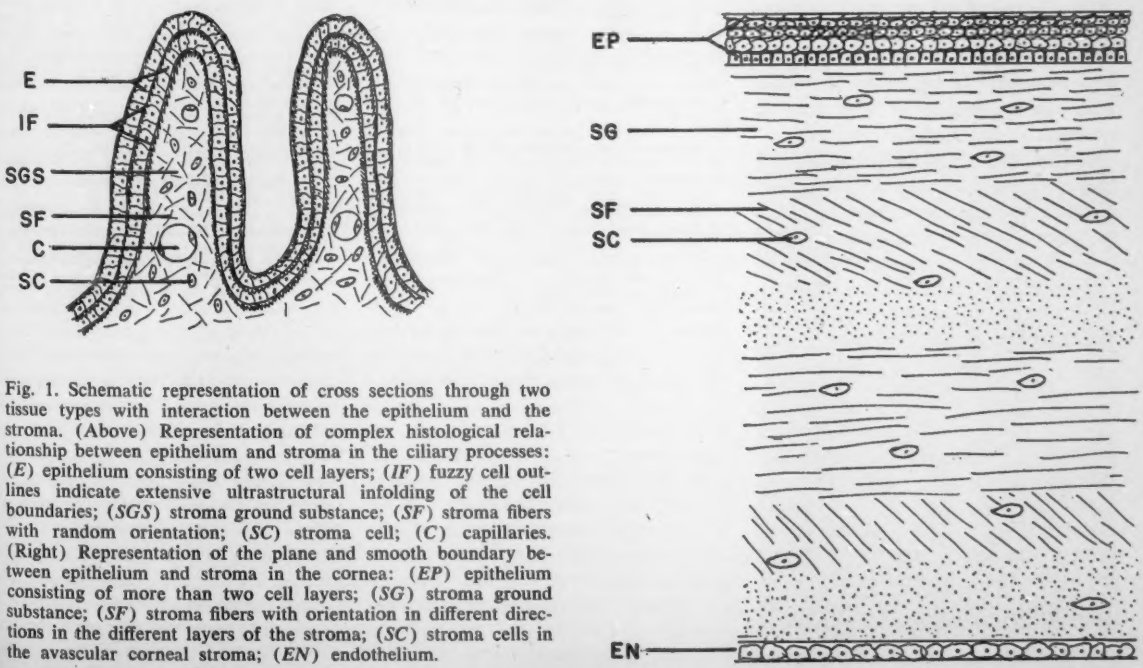


Fig. 1. Schematic representation of cross sections through two tissue types with interaction between the epithelium and the stroma. (Above) Representation of complex histological relationship between epithelium and stroma in the ciliary processes: (*E*) epithelium consisting of two cell layers; (*IF*) fuzzy cell outlines indicate extensive ultrastructural infolding of the cell boundaries; (*SGS*) stroma ground substance; (*SF*) stroma fibers with random orientation; (*SC*) stroma cell; (*C*) capillaries. (Right) Representation of the plane and smooth boundary between epithelium and stroma in the cornea: (*EP*) epithelium consisting of more than two cell layers; (*SG*) stroma ground substance; (*SF*) stroma fibers with orientation in different directions in the different layers of the stroma; (*SC*) stroma cells in the avascular corneal stroma; (*EN*) endothelium.

in these two tissues and determine thereby their histological character.

The results obtained through analysis of the corneal tissue interaction should be directly pertinent to an understanding of embryonic systems in which growth and differentiation of a mesodermal component depend upon the presence of ectodermal cells. This could be expected to be true particularly in the developing limb (*10*) and wing bud and in some forms of limb regeneration (*32*). In this connection, several investigators have found that the normal development of the mesodermal skeleton depends upon the presence of a specific thickening in the ectodermal cover of these primordia. In turn, in the absence of an appropriate mesodermal component, thickening of the ectodermal cover does not occur. Other types of embryonic ectodermal-mesodermal interactions, such as those between somites and neural tissue (*33*) and those observed in several in vitro systems (*9*), may show more or less closely related mechanisms as part of the total differentiation process.

The demonstration of pathways of metabolic interactions between cells may lead to a reconsideration of earlier thoughts about the role of metabolism in morphogenesis, such as the gradient theories of Runnstrom (*34*) and Child (*35*). The significance of these theories was never fully appreciated because they failed to establish a relation between the observed metabolic parameters and synthetic processes which determined, at least in part, the progress of development in the analyzed tissues. With the recognition of a control of syntheses by intercellular metabolic interactions, these early observations may become more meaningful. Also, new and pertinent data have been obtained by Spratt (*36*) and by Backstrom (*37*). It is of particular interest that many data in this work point to sulfhydryl groups of small molecular substances and of proteins as the key to the metabolic control of embryogenesis. In view of work on sulfhydryl proteins mentioned above (*24*), it may be that large molecular sulfhydryl compounds constitute a component in the unification of structural and functional aspects of developing tissues. Possibilities of a control of protein synthesis in one tissue by supply of essential amino acids from an adjacent tissue have been pointed out by Wilde (*38*).

Metabolic cell interactions may also occur in adult tissues, although the slow rate of syntheses may make their detection more difficult. Nevertheless, a more intensive search for such possibilities in adult tissue seems desirable, since some degenerative processes may well be brought about by a failure of just such direct metabolic interactions between cells (*39*).

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Franklin S. Harris, Agronomist, Educational Administrator

The present concern of the United States with an abundance of food instead of famine is due, in great measure, to the contributions of such men as Franklin Stewart Harris. His pioneering contributions to the agriculture of arid regions have served as a solid foundation for the development of irrigated agriculture in the United States. As an educator and as president of two universities, he had a profound influence in stimulating large numbers of young people to seek careers in science. As an adviser to foreign countries, he paved the way for better agriculture and friendly relationships with the United States.

Harris was born in Benjamin, Utah, in 1884 but spent his youth in northern Mexico. His college training was received at Brigham Young University, Utah State University, and Cornell University. Immediately thereafter he returned to Utah State University as soil chemist. There he produced numerous technical publications on the effects of irrigation practices on the yield and composition of crop plants. He also helped plan and conduct some of the first experiments on fallowing land in order to conserve moisture and increase yields of wheat under arid conditions. During this period he became interested in salt and alkali in soils and studied their effects on soils and plants. His book *Alkali Soils* was a unique summary of information up to 1921.

Modern irrigation in the United States began in 1847 with the Mormon pioneers, near the center of what is now Salt Lake City. Arriving in the dry, sun-baked valley on 24 July, they diverted water from City Creek onto the land to provide moisture for plowing and planting of crops. Experimental work in irrigation was initiated by the Utah Agricultural Experiment Station in 1889, and scientific principles involving soil and plant science were developed, in a large measure, by the studies of J. A. Widtsoe and F. S. Harris. They measured the water applied and the effects of this on the growth habits and yield of several crop plants. The results and conclusions obtained by these two agricultural scientists were basic to irrigation in agriculture until superseded in the last ten years by newer concepts and findings.

Although fallowing land to increase crop yields goes back to Old Testament history, the modern practice of alternating crop and fallow for wheat production under arid conditions was first worked out in northern Utah in the middle part of the 19th century. Research on this practice, known generally as dry-farming, was first initiated in 1901. Harris became involved in some of the early experiments and helped to plan and carry out some of the first studies to measure the moisture and nutrient build-up in fallowed soils and the effects of these on crop growth.

In addition to conducting a vigorous and productive research program, Harris was active in scientific societies. He was elected president of the American Society of Agronomy in 1920. He helped organize and held offices of leadership in the Utah Dry Farmers' Association and the Utah Irrigation and Drainage Congress. His broad experience and unusual memory made him an excellent teacher. He stimulated large numbers of young men from the West to become technically educated and to advance to positions of leadership in agricultural science.

Only five years after receiving the doctoral degree he became director of the Utah Agricultural Experiment Station (1916). At a time when agricultural science was still too often limited to field observations, he insisted on precise measurements and on combining field studies with chemical and physical investigations under controlled laboratory and greenhouse conditions.

Harris served as university president for 29 years—24 years at Brigham Young University and five years at Utah State University. During this period the state of Utah reached a position of sending more than twice the national average of its college graduates into science, as listed in *American Men of Science*. As president of two of the three universities in the state, Harris was an important force in encouraging graduates to go into science.

Harris had a special gift for providing the practical illustration or phrase that would illuminate the heart of a problem. He was the rare kind of man of whom it can be said that he was thoughtful of others without having to think about it. He will be long remembered for the force of his personality and the warmth of his friendship. He seemed never to forget any former student and could recall him by his first name after an absence of many years.

In the midst of his busy life as research scientist in agriculture, teacher, and university president, Harris found time for several missions to help agriculture and education in other countries. In 1926 he served as chairman of the Agricultural Sections of the Pan-Pacific Congress in Japan. Then, later, he was made chairman and agriculturalist of the Jewish Colonization Organization of Russia, which was contemplating Jewish settlement of a tract of land along the Amur River in Siberia.

Perhaps the most noteworthy of his foreign accomplishments resulted from missions to the Middle East in 1946 and again in 1950. The contacts and

Franklin Stewart Harris

close relationships he established with leaders in Iran were important in cementing the present close relationships between that country and the United States.

Throughout his career Harris had the warm support of his wife, Estella Spilsbury Harris. She accompanied him to public functions and made their home notable for generous hospitality, and together they reared a distinguished family of six children.

The death of Harris in April of this year terminated a busy career which had been a source of inspiration to thousands of college students. He had produced six books and numerous scientific articles and had guided the development of agriculture in several foreign nations as well as in the western United States.

WYNNE THORNE
Agricultural Experiment Station, Utah State University, Logan

Science in the News

Use of Funds from Sales of Surplus Foods for Science and Education Is Not up to Expectations

For six years the United States has been selling about a billion dollars' worth of surplus food abroad each year. Most of the money is given back to the purchasing country in the form of outright grants or long-term loans.

About one-fifth of the money is actually available for the United States to spend. Most of this "U.S. use" share of the proceeds is used to supply the foreign currency needs of American diplomatic and military personnel in the countries involved in the sales agreements. Some of it is earmarked for such programs as the Fulbright scholarships and agricultural research. In a few countries there is an excess of currency. We have more than we can spend, and to remove this embarrassment of riches Congress last year authorized the use of excess foreign currency for such things as scientific and cultural ventures. But the effects of this new authority have, so far at least, turned out to be unimpressive. Indeed, due to some wording slipped in late in the Congressional deliberations, the amendments to Public Law 480 intended to expand the science and education programs financed under this act have actually had the effect of inhibiting those activities.

The law is known formally as the Agricultural Trade Development and Assistance Act of 1954, and more familiarly as simply PL 480, despite some efforts to give it a more impressive title, such as the Food for Peace Act. Essentially the law represents an effort to get rid of some of our immense food surpluses to the mutual advantage of ourselves and the rest of the world.

During the last fiscal year (ending 30 June 1960) the "U.S. use" share of the proceeds came to just over a quarter of a billion dollars, or 22 percent of the total value of the food shipped abroad. Of this, only $5.1 million was available for the scientific, medical, and cultural programs under the new authority given in the 1959 amendments. Nearly 80 percent of this limited amount was for agricultural research, the remainder was for the National Science Foundation translation program. This was spent in three countries: Yugoslavia, Poland, and Israel. The Yugoslavs and Poles worked mainly on translating their own publications into English; the Israelis worked mainly on English translations of Russian work.

There was no money available for such newly authorized programs as the acquisition and distribution by the Library of Congress of foreign publications and the establishment of chairs in American studies in foreign universities. The limited "U.S. use" funds are, in most countries involved in the program, fully committed to cover the needs for foreign currency under the older programs, which have priority. The new authority to pay for cultural, scientific, medical, and educational activities (Section 104k) only becomes useful when the government finds it has an excess of foreign money that might otherwise go unused. As interpreted by the Bureau of the Budget, this means that no money can be made available for the new programs until the U.S. has accumulated a backlog of several years' currency in a country, enough to meet any shortage that might develop. The decision as to whether there is surplus money available in a given country is somewhat arbitrary, depending on what you call a reasonable layaway for future years. But even the most generous estimators do not see any surplus money in more than a dozen of the 38 countries taking part in the agreements. The Bureau of the Budget, which has the final say, narrows this down to only six. This means there is some but not a great deal of money that might be made available to expand programs under Section 104k next year.

Federal Bookkeeping

To get this money, an agency that would like to spend some excess currency puts in a request with the Bureau of the Budget. The bureau then distributes whatever excess money there is available among the requesting agencies. The agencies put the requests, in terms of the equivalent in American dollars, into their next budget request to Congress. If they get an appropriation they draw the money out of the Treasury and give it to the Commodity Credit Corporation, which handles the PL 480 program, and in return draw the equivalent in foreign currency. Thus, although for bookkeeping purposes the money appears as an addition in dollars to the agency's budget, the American money merely travels around within the government. Nevertheless, in the view of some critics this bookkeeping arrangement has had an unfortunate effect on the programs for using excess PL 480 funds. These critics, including some within the Administration, suggest that the Bureau of the Budget is so intent on keeping the federal budget as low as possible that it tends to try to cut down even spending of excess foreign currency under PL

480. For, although this involves no actual expense to the government, the bookkeeping arrangement does lead to an apparent increase in the budget.

There will probably be an increase of Section 104k programs in the years ahead. Neither Nixon nor Kennedy is as conservative on budget questions as Eisenhower has been, and both insist that they will vigorously support an expansion of sales of surplus goods; this will make more PL 480 funds available in any case. Meanwhile, unless Congress finds time in the current hectic session to alter the wording that went into the law with Section 104k, the chief immediate effect of this amendment designed to increase spending on scientific, educational, and cultural activities will be to limit such activities.

What happened was that Senator Ellender of Louisiana, who has long been irked by what struck him as excessive waste in the foreign aid programs, took the opportunity while the bill was being prepared for final passage in a House-Senate conference to insert a clause requiring that any spending for the *purposes* of Section 104k—that is, for medicine, science, education, or culture—had to be authorized by a specific Congressional appropriation. It is not clear whether the majority of the conference committee realized at the time that Ellender's wording would apply to any spending of PL 480 money for such purposes, and not only to the spending of excess "U.S. use" money. The Administration has been trying to have a correction made, but so far without success. Efforts to add a correcting amendment to this year's Mutual Security bills were killed in committee in both the House and Senate on the grounds that such a correction could not properly be included in the legislation at hand. It now appears unlikely that a correction will be made before some time next year. Meanwhile, when the State Department negotiates a trade agreement under PL 480 it can readily agree to make some of the foreign country's share of the funds available for building a road or a dam, but if the country wants some money for a school or a laboratory, the State Department must tell it to wait until a specific appropriation can be gotten from Congress. This takes about 18 months, and the State Department's negotiators have been having some difficulty in explaining that, despite the delay, the United States really has nothing against science and education.

Treaty Reducing Tariffs on Books, Art, and Scientific Instruments Takes Another Small Step Forward

The State Department has now sent to Congress draft legislation to implement the Florence Agreement on removing tariffs and import restrictions on scientific, educational, and cultural material. There is not enough time left, at this late date, for the legislation to be put through in the current session. But it appears that the agreement is likely to actually go into effect some time next year. It has been in the works for a dozen years.

The State Department says it is uncertain about the likely effects of the agreement. They are not likely to be earth-shaking. But implementation of the treaty will mean tariff reductions that will save a fairly substantial amount of money for educational institutions buying certain narrowly restricted types of scientific equipment. It will allow modest savings for people who buy books that have been published abroad. The most obvious beneficiaries will probably be museums and art collectors who for years have felt harrassed by customs inspectors who have frequently insisted that works of modern art were not really art under the provisions of the U.S. customs regulations and were therefore subject to the heavy import duties laid on "decorations."

The Florence Agreement was negotiated in 1949 by the United States and other members of UNESCO. In June 1959, the United States became the 31st country to sign the agreement. The Administration asked the Senate for its advice and consent at the end of August 1959. By that time it was too late for the Senate to act, but hearings were held in January of this year, soon after the new session began, and on 23 February the Senate consented to ratification by a vote of 71 to 14. The debate was brief. The only criticism was voiced by Senator Cotton (R-N.H.), who said that he would have to vote against the treaty because although no communist countries had joined the agreement it was possible some might and he didn't want to undergo the risk of this country "opening the door to an influx of literature from those countries." The principal items covered by the treaty are books, works of art, and, with severe limitations, scientific instruments.

The treaty's actual effectiveness will depend very much on the way in which the next Administration chooses to interpret it. There are several escape clauses, the most important allowing a country to clamp on tariffs or import quotas in spite of the treaty if it feels the imports might unreasonably damage domestic producers of similar goods.

In the case of scientific instruments the treaty is especially limited: it applies only to instruments going for research purposes to educational institutions. Individual buyers will not benefit, and in any case the treaty will apply only when instruments equivalent to the ones being imported are not produced within the importing country. This means that a foreign microscope costing $100 could not be imported duty free unless it were superior in some way to any microscope produced in America, no matter what the price.

Another escape clause, intended primarily for books, allows the treaty members to bar any items they regard as a threat to "national security, public order, or public morals." Despite this, none of the communist countries has shown any interest in signing the agreement. They apparently share Senator Cotton's apprehensions about the danger of opening their countries to an influx of literature from foreign countries.

Implementing Legislation

Under the Constitution treaties are self-implementing—that is, their provisions take precedence over any domestic laws to the contrary. But as a practical matter the Administration makes a practice of holding up the final steps of ratification of most treaties until Congress has passed legislation revising domestic laws to conform with the treaty, assuming such revisions are necessary. In this case, the necessary revisions relate to the elimination of tariffs and import quotas on the goods covered by the treaty and to establishing some mechanism for deciding when use of the escape clauses might be justified. After the Senate approved the treaty it took six months for the various interested agencies (the State Department, the Treasury, the Tariff Commission, and several others) to confer among themselves over who should make the determination. This accounts for the delay between the time the treaty was approved and the submission of draft legislation. Actually no decision was ever made. The draft legislation simply grants the President the power to designate someone who

will make the decision. Congress, of course, can alter the draft legislation as it pleases and will probably be more specific about who is to decide when to apply the escape clauses.

Opposition Active

Congressional action, though, will not come until some time next year. There would be only the slightest chance of the legislation getting through during the current brief session even if there were no opposition. In fact there is some opposition, which removes any possibility of Congressional action during the current rump session. O. R. Strackbein, who runs an all-purpose high-tariff lobby known as the Nationwide Committee of Industry, Agriculture, and Labor on Export-Import Policy, has informed the House Ways and Means Committee that he would like to testify against the treaty. The Scientific Instrument Manufacturers Association also opposes the treaty. There may be others.

The most active group lobbying for the treaty has been the book-publishing industry, which hopes the treaty will make it easier to sell American books in Canada. The book printers, and the printers unions, on the other hand, seem to have their doubts about the benefits, and some of them, at least, are against the treaty. (Book publishers do not normally own the companies that print their books.) It was in deference to the printers that the United States delayed for so many years before signing the treaty. The International Copyright Agreement was signed about the time the Florence Agreement was opened for signatures. That, too, provided for removing some restrictions on importing books, and the State Department accepted the printing industry's view that the industry should not be subjected to a further lowering of protection until the effects of the first could be gaged. The State Department has a tough fight on its hands every time the Reciprocal Trade Agreements Act (i.e. lower tariffs) comes up for renewal in Congress, and it doesn't like to offend any more people than it has to. The British, for their own reasons, took a long time to get around to joining the International Copyright Agreement, and it therefore was not until 1959 that the State Department felt it had enough evidence to indicate the lowered import barriers were causing no discernible damage to the American printing industry.

Scientists Concerned over Fate of Congo Parks

It is a matter of grave concern to natural scientists the world over that the newly established Congo Government should take appropriate measures to safeguard the unique sanctuaries for Central Africa's fauna and flora that are now found within the Congo parks. It is hoped that the new government will not hesitate to call upon the United Nations and its specialized agencies, as well as the International Union for the Conservation of Nature, to furnish it with scientific and technical assistance in carrying out a task which is of such concern to the world of science.

A great achievement in the field of the natural sciences has been accomplished during the past 30 years by Victor Van Straelen, a far-sighted and distinguished Belgian naturalist, with the support of the Belgian Government and the assistance of a small staff of dedicated Belgians and Congolese. More than 10,000 square miles of biogeographically differing territories of tropical Africa have been established in four great natural parks to protect the fauna and flora within these areas from outside influences and to preserve them for the future benefit of mankind.

The parks are the Albert National Park, bordering Uganda (3160 square miles); the Garamba National Park, bordering the Sudan (1922 square miles); the Upemba National Park, in Katanga (4581 square miles); and the Kagera National Park, in Ruanda and bordering Tanganyika (980 square miles). Altogether the parks occupy about 1 percent of the entire land area.

There is little awareness that no large areas in the tropics have been as intensively scientifically studied and inventoried as those that lie within these four parks, which have been administered since 1929 by the Institute of the National Parks of the Congo and Ruanda Urundi, with a board of directors made up of two-thirds Belgians and one-third conservation leaders from England, France, Holland, Portugal, Switzerland, and the United States.

The Congo parks, which include a wide range of habitats from high rugged mountains and active volcanoes to grassy plains and lakes teeming with animal life, have been largely protected against the influence of outside forces, including man. They have been administered in such a way as to preserve as far as possible the natural balance of their biotic environment from the smallest microscopic worm to the largest elephant, from the largest trees to the most inconspicuous mosses. In fact, these parks represent what was defined by the London African Convention of 1933 as "integral natural reserves" or what we call in this country "primitive areas," areas that have been set aside within our national parks or forest reserves which are not usually open to the general public. In fact, it was the American naturalist, Carl Akeley, who encouraged King Albert back in 1925 to issue the decree first establishing the Albert National Park to protect the habitat of the mountain gorilla. In the Congo parks, such rare species as the northern white rhinoceros and the mountain gorilla have complete sanctuaries, as do hundreds of species of African animals, each filling its niche in a relatively undisturbed natural biotic community.

It should be pointed out that the Institute of National Parks has allowed limited access to certain sections of the parks to the tourist public, particularly in the Ruindi-Rutshuru plains area of the Albert National Park, which has attracted several thousand visitors and tourists each year with its antelope, buffaloes, hippos, lions, and elephants. However, as a general policy, in the rest of the parks access roads have been kept at a minimum, while a wide variety of scientific research has been constantly under way.

The scientific effort that has gone into the study of these parks is evidenced by the fact that back in 1956 the Institute had issued 262 scientific reports totaling more than 20,000 pages, including descriptions of 2467 new species. Their photographic record at that time included more than 50,000 prints. Sample subjects that were dealt with in these comprehensive scientific reports include fossils, plants, insects, reptiles, large mammals, soils, hydrology, geologic structure, and volcanoes.

During the 25 years from 1932 to 1956, 13 naturalists were engaged in repeated field missions, assisted by 34 additional scientists supported by funds of the Institute, with the result that the three biologically differing areas of the Albert, Garamba, and Upemba Parks were so intensively studied that their fauna and flora are actually more thoroughly known than those of any large African area, or in fact of any extensive tropical area in the world. The

identification of the vast collections that have been assembled there is still under way, and has involved taxonomists in many fields from various countries. From a scientific point of view, the inventories of the fauna and flora of the Congo parks, some of which have been published and many of which are still in preparation, make these areas particularly suitable for future ecological studies.

It should also be borne in mind that the Congo parks can be of great economic value, not only on account of their interest to visitors and tourists, but also because they furnish a reservoir of species of future value to the Congo as well as to other tropical areas of Africa. They additionally help to stabilize the climate and water resources for extensive agricultural lands adjoining the park boundaries.

HAROLD J. COOLIDGE
International Union for the Conservation of Nature and Natural Resources, Washington, D.C.

News Notes

Soviet Recovers Dogs from Orbit; U.S. Snares Capsule in Air

The Soviet Union has retrieved two dogs and other unidentified animals from an orbiting satellite; this is the first time that living creatures have been recovered from space. The cabin in which the animals traveled for 24 hours was equipped with television transmitters so that the animals could be studied while in flight. The 5-ton satellite circled the earth 17 times before the cabin was detached (on 20 August) and sent back to earth from an altitude of 198 miles. It landed within 6 miles of a precalculated landing site. All the animals are reported to be in good condition.

The Soviet success overshadowed a United States achievement of the previous day, the retrieval by the Air Force of an ejected Discoverer satellite capsule at an altitude of 10,000 feet, the first recovery to be made in the air. As it parachuted down, the 85-pound payload was snared by a plane equipped with hooks. Eight days earlier the Air Force had succeeded in making the first recovery of a man-made object from orbit when it retrieved from the sea an instrument capsule ejected by Discoverer XIII.

Rabi Attacks Secrecy in Government

I. I. Rabi, Columbia University physicist and Nobel Prize winner, says in the August *Atlantic* that he has been "forced to the conclusion" that many of this country's policy difficulties stem from distortion caused by "the exaggerated secrecy in the military field, and in the atomic field especially." Rabi is former chairman and now a member of the President's Science Advisory Committee. In his article on "The Cost of Secrecy" he warns that although most policy makers, amateur or professional, are not deeply interested in or capable of judging the technological situation, secrecy results in frustration, doubt, and timidity about the exercise of any independent judgment.

"The result," says Rabi, "has been that a number of less inhibited men of greater or lesser scientific or technical accomplishment, but with a low boiling point, have been gaining the public ear on the basis of prestige acquired through a technical accomplishment quite limited in scope. Their policy statements are given weight on the basis of skills not necessarily relevant to the dread subjects of war and peace, which they discuss with confidence.

"Were it not for the secrecy which hides the hard core of the matter, the intelligent public would be quite capable of judging the questions under discussion. The fear of being guilty of judgment based on a partial knowledge of the facts misleads many judicious people into accepting judgments by others whose knowledge is often even more partial but which extends into the dread domain of the top-secret."

Rabi points out that the government cannot act strongly without ample support from public opinion. He says:

"When secrecy intervenes, an informed public opinion can hardly exist. Too often we have, instead, a manipulated public opinion formed by leaks, half-truths, innuendoes, and sometimes by outright distortion of the actual facts. . . .

"The difficulty of secrecy within the government is that, unless administered with the greatest wisdom, it furthers confusion, which comes from ignorance or partial knowledge, and often results in inaction or unwise acts. The farcical snafu of the U-2 incident with all its overtones of tragedy shows how great the costs of secrecy can be, even in the highest echelons of government.

"We can now ask ourselves, what have we really gained from our exaggerated secrecy in the way of real security? Actually, very little. The Russians are not far behind us in atomic weapons, but our allies have been left way behind, after expending an enormous treasure in trying to rediscover facts and techniques already known to the Russians as well as to ourselves."

International Nutrition Congress Holds First United States Meeting

Leading research scientists in the field of nutrition from 59 countries will present reports of their recent investigative work at the fifth International Congress on Nutrition in Washington, D.C., 1–7 September. In addition to a White House representative, Secretary Benson of the Department of Agriculture and Secretary Flemming of the Department of Health, Education, and Welfare will welcome the 2500 or more specialists expected to be present.

W. Henry Sebrell, Jr., of Columbia University, chairman of the program committee, has announced that there will be seven half-day panel discussions led by 50 invited scientists from 20 foreign countries and the United States. There will also be 37 special sessions at which 370 ten-minute papers reporting unpublished results of original research will be presented by approximately 500 investigators from almost every country in the world. The congress will close on 6 September with an all-day symposium on world food needs and food resources, followed by an all-congress banquet. Headquarters hotels will be the Sheraton-Park and Shoreham.

Sponsors and Officers

This is the first time that an International Congress on Nutrition has been held in the United States. This fifth congress is being arranged under the auspices of the International Union of Nutritional Sciences, the American Institute of Nutrition, and the U.S. National Committee of the International Union of Nutritional Sciences of the National Academy of Sciences–National Research Council. Several agencies of the United States Government, as well as American foundations, institutions, and interested segments of industry, are providing financial support.

The organizing committee for the congress is under the chairmanship of Paul György, professor of pediatrics at the University of Pennsylvania, and C.

Glen King, executive director of the Nutrition Foundation, Inc., is congress president. The general secretary is Milton O. Lee of the Federation of American Societies for Experimental Biology.

Sanitary Engineering Survey Launched in Latin America

Gordon M. Fair of Harvard University has been appointed by the Pan American Health Organization to initiate a survey on the teaching of sanitary engineering in Latin America and to present a series of lectures on current sanitary engineering subjects. Fair, who is Harvard's Abbott and James Lawrence professor of engineering and Gordon McKay professor of sanitary engineering, will have toured 11 Latin American nations when he returns to the United States in late September.

He is discussing sanitary problems with government officials and is visiting schools of engineering in Mexico, Guatemala, Panama, Colombia, Ecuador, Peru, Chile, Argentina, Uruguay, Brazil, and Venezuela, in that order. Fair's survey material will also be used as the basic data to be studied at a seminar on the teaching of sanitary engineering which PAHO will sponsor in 1961.

Intergovernmental Oceanographic Commission Recommended

Representatives from 34 countries attended the UNESCO-sponsored International Conference on Oceanography in Copenhagen, Denmark, 11–16 July. The seven-man delegation from the United States was headed by James H. Wakelin, Jr., Assistant Secretary of the Navy for Research and Development.

The conference recommended that UNESCO set up a permanent intergovernmental oceanographic commission (IOC) to coordinate oceanographic research by states and international bodies. The Intergovernmental Oceanographic Commission would work with a special Office of Oceanography within UNESCO's Department of Natural Sciences to coordinate research on a permanent basis, the commission meeting once a year. This is subject to final approval by the General Conference of UNESCO in November.

The conference recognized that one of the chief obstacles to oceanographic research is the lack of qualified oceanographers, and it recommended that the number of fellowships financed by UNESCO be appreciably increased so as to offer greater training facilities for such specialists. UNESCO was also asked to organize a conference of deans of science faculties or science professors from all parts of the world to discuss the means of developing university teaching in the marine sciences.

Other steps toward international cooperation recommended by the conference are standardization and intercalibration of methods and equipment, the collection and exchange of oceanographic data, and the organization of joint research programs in specified regions by groups of countries, such as the one planned for the Indian Ocean. The conference also voted a resolution asking governments and international organizations to take immediate steps to prevent pollution of the sea and to intensify research in this field.

Funds for Basic Research Estimated at $1 Billion a Year

The National Science Foundation estimates that total funds for the performance of basic research in the United States reached a level of $1 billion in the year 1959–60. The amount is based on a new statistical report, "Funds for the Performance of Basic Research in the United States, 1953–58," the 22nd publication in the NSF series *Reviews of Data on Research & Development.*

The recent survey indicates that basic research funds rose from about $430 million in 1953–54 to more than $830 million in 1957–58, an increase of 93 percent. However, throughout this period funds for basic research continued at a level of about 8 percent of the total estimated research and development funds, which reached a $12 billion annual level for 1959–60. The substantial rise in the level of basic research funds is part of a "long-term increase in scientific and technological activity," the foundation said.

The series indicates that colleges and universities expended about half the national total in the performance of basic research in the 1957–58 survey year. The industry sector reported using about a third of total national funds for the same purpose. Performance of basic research by both the federal government and other nonprofit institutions accounted for a relatively smaller portion of funds, 13 and 6 percent, respectively.

The federal government provided the largest amount of basic research funds in the 1953–58 period.

No important change was found in the distribution of total funds for the performance of basic research by field of science over the years covered. The physical sciences reached a total of more than $550 million, or approximately two-thirds of all the natural sciences funds in 1957–58. The life sciences accounted for the remainder of the basic research funds, or about $280 million.

For survey purposes, the foundation defines basic research as scientific inquiry in which the primary aim of the investigator is a fuller knowledge or understanding of the subject, rather than a practical application. (*Reviews of Data on Research & Development,* No. 22, is available from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., 15 cents.)

Mental Health Research Foundation Established

The National Association for Mental Health, New York, has announced that it has set up a foundation to conduct its research activities. The association, which has 800 affiliates in 45 states, also conducts a nationwide program of services to the mentally ill and their families, as well as a program of mental health education.

The new research unit, the Research Foundation of the National Association for Mental Health, will allocate grants for projects and programs concerned with the causes, prevention, treatment, and cure of the many different mental illnesses. It will also provide fellowships for medical students interested in research on mental illness. The foundation will thus assume the functions of the association's research department, which has been operating since early 1959.

Harold Elley of Wilmington, formerly chief of research of E. I. du Pont de Nemours Company, is the foundation's first president. Its director is William Malamud, who also serves as director of professional services of the National Association for Mental Health.

News Briefs

Deep Freeze's sixth season. Christchurch, New Zealand, is the advance base for United States antarctic operations, called Operation Deep Freeze. With the coming of the New Zealand spring, fleets of long-range aircraft bring men and supplies for the air and sea lift to Antarctica.

The first supplementary base personnel reached Christchurch at the beginning of August, 2 weeks earlier than usual, to prepare for Deep Freeze's sixth season. Support forces are expected on 2 September, and the airlift is to start in the first week of October. In the following few weeks about 1250 men will pass through Christchurch on their way to the antarctic bases.

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AFC aid to nuclear education. The Atomic Energy Commission has announced that it has extended through 30 June 1964 its programs of assistance for nuclear education in United States nonprofit educational and medical institutions. Some of the programs were scheduled to terminate in 1961. Assistance will be continued on the same bases as in the past, except in one of the programs. In the reactor technology program, no further grants will be made for the construction or purchase of teaching reactors. However, the commission will continue to loan to qualified institutions, without charge, source and special nuclear materials for use in teaching reactors.

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Fungi center planned. The National Science Foundation has awarded a $32,300 grant to a Dartmouth College botany department team to establish a national center for supplying fungi widely used in teaching and research. Raymond W. Barrett will direct the project, assisted by William Ogata.

Between 1000 and 2000 genetic strains of *Neurospora* and *Aspergillus*, fungi useful in teaching and research in genetics, biochemistry, and biological analysis, will be collected and maintained. Scientists and teachers will be able to order stocks free of charge from lists that will be published by the center.

* * *

Biological engineering. A new society, the Biological Engineering Society, was inaugurated at a meeting held at the Royal College of Surgeons in June. The purpose of the society is to bring together members of different disciplines —from hospitals, research institutes, and industry—to further the applications of engineering to biological and medical problems. R. Woolmer, professor of anesthesia at the Royal College of Surgeons, was elected first president. The acting secretary is Dr. A. Nightingale, Physics Laboratory, St. Thomas's Hospital, S.E. 1, London.

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Materials research centers. The Department of Defense, through the Advanced Research Projects Agency, has recently awarded large contracts to three universities—Cornell, Pennsylvania, and Northwestern—to undertake basic research which could lead to the development of new materials for military purposes. The level of support over a 4-year period will be, respectively, $6.1 million, $4.4 million, and $3.4 million. These funds will cover the operating costs of the new research centers as well as provide equipment and facilities. Establishment of additional laboratories at other universities is contemplated. The program is designated Project Pontus.

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Chemical society to meet. Some 1500 papers will be presented at the 138th national meeting of the American Chemical Society, which will be held in New York, 11–16 September. "A Chemist Looks at the World Population Explosion" is the title of the chief address, to be given by Albert L. Elder, president of the 90,000-member society and director of research of the Corn Products Company, Argo, Ill. Five Nobel Prize chemists are on the meeting program: Frederick Sanger of Cambridge University, Severo Ochoa of New York University, Glenn T. Seaborg of the University of California, Peter J. W. Debye of Cornell University, and Linus Pauling of California Institute of Technology.

* * *

Atomic energy and health. Eight United States experts will participate in an International Symposium on Legal and Administrative Problems of Protection in the Peaceful Uses of Atomic Energy. The symposium will be sponsored by the European Atomic Energy Community (EURATOM) 5–8 September, at Brussels, Belgium. It is the first of its kind to be held in Europe. Experts in the legal and technical fields from 15 nations and several international organizations will discuss international legal and administrative problems of health protection raised by the increasing use of atomic energy for peaceful purposes.

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U.N. resolution on abstracting. A resolution calling for a study of abstracting services in various branches of science and technology as a basis for future action in the field of scientific inquiry has been adopted unanimously by the Coordinating Committee of the United Nations Economic and Social Council. The adoption of the resolution followed 2 days of debate on a special report on "the survey of the main trends of inquiry in the field of the natural sciences, the dissemination of scientific knowledge and the application of such knowledge for peaceful ends."

Scientists in the News

S. A. Schelkunoff, assistant vice president of Bell Telephone Laboratories and an internationally recognized mathematician, retires from Bell Laboratories on 1 September after nearly 35 years of service. He has been appointed professor of electrical engineering at Columbia University.

During his telephone career, Schelkunoff made fundamental contributions in the field of electromagnetic theory, in theoretical studies of waveguides for transmitting microwaves, and in research on antennas for radio communication. He is the author of four books, and some 50 technical articles, and he has been granted 15 patents.

S. A. Schelkunoff

L. C. Birch has been named Challis professor of zoology and head of the department at the University of Sydney. Birch, well known for his studies in ecology, evolution, and population genetics, spent a year at the University of Chicago in 1946–47 and another at Columbia University in 1954. In 1959 he was visiting professor of zoology at the University of Minnesota.

Frederick J. Stare of the department of nutrition at Harvard University has been appointed a member of the AAAS–Theobald Smith Award judging committee to replace Arnold D. Welch of Yale University School of Medicine, who found it necessary to resign from the committee.

Two members of the Chemistry Division of Argonne National Laboratory, **Henry R. Hoekstra** and **Herbert H. Hyman**, have begun 1-year research assignments at the United Kingdom Atomic Energy Establishment, Harwell, England, under a staff exchange program between Argonne and the British laboratory.

Robert Bruce, psychologist and dean of the Graduate School at the University of Wyoming, has been named chief of the Graduate Fellowship Program (Title IV) of the National Defense Education Act. He will assume his post at the U.S. Office of Education in Washington in September. Bruce succeeds **Henry E. Bent**, who has returned to his position as dean of the graduate faculty and professor of chemistry at the University of Missouri.

E. J. L. Lowbury, member of the British Medical Research Council's scientific staff at the Industrial Injuries and Burns Research Unit, Birmingham Accident Hospital, Birmingham, will attend the International Congress on Research in Burns that will be held in Washington, D.C., 19–22 September. His itinerary includes: New York; Cleveland and Cincinnati, Ohio; Fort Sam Houston and Galveston, Tex.; Louisville, Ky.; and Boston.

Austin C. Wagenknecht has been employed by General Mills, Inc., Central Research Laboratories, Minneapolis, as principal scientist in charge of lipid research in the fundamental food research department. Wagenknecht joins the laboratories from the New York State Agricultural Experiment Station, Cornell University, Geneva, where he held the position of associate professor of biochemistry in the department of food science and technology.

Carl A. Bunde, clinical pharmacologist, has been appointed medical research director of the Wm. S. Merrell Company, Cincinnati. From 1937 to 1949 Bunde held various teaching positions at the University of Oklahoma School of Medicine, Baylor College of Medicine, and Southwestern Medical School.

Ronald Singer, professor of anatomy at the University of Capetown, has returned to his university after a year as a visiting professor in the anatomy department at the University of Illinois College of Medicine. This year the department will have a visiting associate professor, **John Gamble** of St. Mary's Hospital Medical School, University of London.

In the same department, **James C. Plagge**, professor of anatomy, will return in September after a 2-year leave of absence in Saigon, South Vietnam, where he served as Medical Educator for the International Cooperation Administration.

John A. Clausen, chief of the Laboratory of Socio-Environmental Studies at the National Institute of Mental Health, Bethesda, Md., has been appointed director of the Institute of Human Development and professor of sociology and social institutions at the University of California, Berkeley. He succeeds the late distinguished psychologist, Harold E. Jones, who headed the research installation from 1935 until his death in June.

Terrell L. Hill, professor of chemistry at the University of Oregon, will be on sabbatical leave during 1960–61 in the department of theoretical chemistry, Cambridge University, England.

Arthur B. Cummins, manager of the Central Chemical and Physical Research Department at the Johns-Manville Research Center in Manville, N.J., has retired after 36 years of service. He is an authority on asbestos mining, mineralogy, and filtration technology of silica and diatomaceous earth, and holds 17 patents on silicates, diatomite, magnesia, and scientific apparatus.

Theodore A. Ashford, professor of chemistry at St. Louis University, has been appointed director of the Division of Natural Sciences and Mathematics at the University of South Florida, Tampa. The division will include the departments of chemistry, physics, astronomy, geology, zoology, botany, engineering drawing, and mathematics.

Paul C. Tompkins, for the past 11 years scientific director of the U.S. Naval Radiological Defense Laboratory, San Francisco, Calif., has been appointed chief of the research branch, Division of Radiological Health, U.S. Public Health Service, Washington, D.C. **Eugene P. Cooper**, associate scientific director of the San Francisco laboratory since 1953, succeeds Tompkins as director.

Recent Deaths

Harold L. Alling, Pillsford, N.Y.; 72; geologist; professor at the University of Rochester from 1925 until his retirement in 1953; author of *Interpretative Petrology;* 27 July.

Sigurdur Jonsson, Chapel Hill, N.C.; 41; professor of pharmaceutical chemistry at the School of Pharmacy, University of North Carolina; 16 July.

Arthur W. Klein, Norwalk, Conn.; 79; a retired professor of mechanical engineering at Lehigh University; 13 July.

Harry E. Kleinschmidt, Mystic, Conn.; 76; a retired physician and public health specialist; former health and education director of the National Tuberculosis Association, which he served from 1927 to 1942; author of textbooks on health; 24 July.

Maud L. Menten, East Windsor, Ont.; 81; professor emeritus of pathology at the University of Pittsburgh School of Medicine; 17 July.

Norman S. Olsen, Remsen, N.Y.; 42; biochemist and assistant director of the Masonic Medical Research Laboratory, Utica, N.Y.; previously on the teaching staffs of the University of Michigan, the University of Illinois, Washington University, and Thayer Veterans Administration Hospital (Nashville, Tenn.); 7 July.

Earl D. Osborne, Buffalo, N.Y.; 65; dermatologist and retired professor of dermatology at the University of Buffalo, where he taught for 34 years; 23 July.

Book Reviews

Foreign Aid: Theory and Practice in Southern Asia. Charles Wolf, Jr. Princeton University Press, Princeton, N.J., 1960. xix + 442 pp. $7.50

This is an important book—and a controversial one. It attempts to devise more rational criteria for allocating aid between programs and among countries. It develops new concepts designed to evolve proximate, quantitative expressions for political characteristics. If it were judged by its success in achieving this all but unattainable aim, the book would be rated lower than if one appreciates its pioneering quality. A reviewer who is on record as favoring attempts to introduce more quantitative concepts into the border lands of social science ["Quality into Quantity?," in *The Comparative Study of Economic Growth and Structure* (National Bureau of Economic Research, New York, 1959)], no matter how tentative the result, cannot fail to applaud the tantalizing effort Wolf has undertaken and pay homage to his boldness, ingenuity, and dogged determination.

Inevitably, this volume will be compared with another recent work on foreign aid, George Liska's *The New Statecraft* (University of Chicago Press, Chicago, 1960). No two books on the same subject could be more dissimilar. The political scientist, undeterred by the inherent indeterminacy of concepts, terms, and policy alternatives, uses a broad brush. Wolf, the economist, looks to the record for guidance to the assumptions that seem to be implied in past policy decisions on allocations. The historical and statistical detail contained in the first six chapters is an invaluable contribution in its own right; it will be appreciated by anyone who has been driven to distraction by the inconsistencies induced by changing objectives and by the perennial tug-of-war between the Administration and Congress. And the lavish documentation is a prime guide to hopelessly scattered source material.

But for Wolf this is only the beginning. He wants to supplement the hit-and-miss method of allocating the total amount of available foreign aid. Even if one does not fully accept the confining view that "the problem of increasing the effectiveness of the Mutual Security Program is . . . synonymous with the problem of improving the allocation of aid funds" (page 412), it is certainly true that the method of allocation is an elusive one. And "it is indeed hard to avoid the mistakes or repeat the successes of past decisions if the grounds for having made them cannot be ascertained" (page 68). Hence, Wolf sets out to analyze the tortuous course of past aid allocations in South Asia, the region he knows so well from personal experience. He attempts to circumscribe the objectives of foreign aid, with a view to maximizing the political or military returns from given aid inputs. It is a trenchant analysis, logical almost to a fault, which dots more *i*'s than certain readers may care for; but those who follow the author closely will be rewarded by a clearer insight, along with many shrewd observations, even if they are not willing to accept every detail of Wolf's proprietary method of dissection.

It is indeed a subjective approach, perhaps more so than the author himself is able to perceive. But he remains scrupulously honest in his exposition and in discussing the limitations of the models to which his analysis leads him. He attempts to quantify the "productivity" of aid and its ability to achieve certain objectives, specifically to minimize the political vulnerability of the recipients or to maximize their collective military capability. What cannot be measured directly has to be approximated by something that can, and a disconcerting chain of further simplifications proved necessary in the single test provided. The author has few illusions about the empirical usefulness of his models in guiding the policy maker toward better allocations. In fact, frustration awaits any reader who might be tempted to look for practical application. The unique value of the exercise is the insight that is gained by thinking harder and clearer than customary. As in all theory—and no general theory is attempted by the author—the real gain is proportional to the intellectual investment in rigorous analysis; this is not negligible even though, as Jacob Viner pointed out, "for policy . . . conclusions are vital, and often are all that is vital" [*The Long View and the Short*, (Free Press, Glencoe, Ill., 1958)]. In this sense, the last six chapters of the book do not deal with policy, but with the theory of policy, and in a highly original manner.

HENRY G. AUBREY
Council on Foreign Relations, New York

Radiation. Use and control in industrial application. Charles Wesley Shilling. Grune and Stratton, New York, 1960. viii + 223 pp. Illus. $6.75.

Atomic energy has brought a new factor into man's environment: nuclear radiation. Applications and uses of radioactive isotopes in industrial processes, in the development and operation of power plants, in the manufacture of radioactive preparations, and in instrumentation grow continuously. Paralleling this increase in the use of isotopes is an increase in the possibility of harmful exposure. Sooner or later all who are concerned with practical medicine have to give intelligent answers to questions, worries, and fears about the real and the imagined dangers that result from atomic radiations. Moreover, the industrial physician, obliged to follow modern technical developments in industrial methods with their imminent dangers for life and health, has to cope with and to help in possible radiation emergency cases.

The present monograph, Number 5 in the series "Modern Monographs in Industrial Medicine," gives the needed information about the real facts and dangers involved in work with isotopes. Five sections and an appendix are devoted to discussions of the physical and biological fundamentals of radia-

tion and radiation effects (including somatic and genetic effects), the prevention and treatment of radiation injury, the methods and means of controlling radiation, and an elaboration on the use of radioactive isotopes in research, medicine, and industry. The presentation is nontechnical, clear, and concise. A glossary and selected references assist and stimulate further studies.

The book reflects the author's great experience; this experience, based on many personal contacts, discussions, conferences, and private studies, enables him to provide information in a logical and perfect form for those who must acquaint themselves with the effects of ionizing radiations on man. It is an eminently practical book.

A. T. KREBS
U.S. Army Medical Research Laboratory, and *Biology Department, University of Louisville*

Indian Scientific and Technical Publications. Exhibition 1960, a bibliography. Compiled by the National Library, Calcutta. Council of Scientific and Industrial Research, New Delhi, India, 1960. xii + 393 pp. Rs. 25.

This bibliography, which originated in an exhibition of Indian publications held at the National Library in Calcutta, covers books and periodicals in all the major scientific and technical areas, including certain characteristically Indian subjects, such as ayurveda and yoga and the sago and vanaspati industries. As one would expect in a country at India's stage of economic development, the emphasis in the compilation is on topics in the applied sciences and, in terms of type of materials, on handbooks and textbooks at the intermediate and college level.

The total number of entries is 4800. In Part 1, about 2900 entries represent 13 Indic languages (for example, Hindi, 800; Marathi, 360; Bengali, 350; Tamil, 270; Urdu, 180; Sanskrit, 120). Approximately 10 percent of the entries are translations. Among the subject fields, medicine leads with about 800 publications, followed by agriculture, 400; engineering, 220; physics, 190; general science, 180; astronomy, 150; and so forth. In Part 2, 1900 English titles are distributed among agriculture, 500; engineering, 320; medicine, 190; mathematics, chemical technology, and physics, about 100 each; the other fields of science and technology are represented by fewer than 100 titles each.

The bibliography is arranged according to the Dewey decimal system and has three voluminous indexes: an author-title index for each part and a combined subject index for both parts. A directory of the contributing Indian publishers rounds out the volume.

As the compilers themselves point out, the merits and shortcomings of this bibliography are inherent in the event that occasioned it. The fragmentary quality of the contributions submitted for the exhibition by the publishers of India is reflected in the compilation, despite attempts of the National Library to fill in the gaps (especially from its own Indic languages collection). The Library plans to correct this deficiency by publishing a supplement at an unspecified later date. A lesser fault is that the reader not familiar with the Indic languages is rather at a disadvantage in scanning Part 1, since no English translation or annotation of the transliterated (Hunterian system) titles is given.

Nevertheless, this is a major and up-to-date bibliography of scientific and technical monographs and serials issued in India. It is a useful adjunct to such bibliographic tools as the INSDOC and UNESCO bibliographies in this field and to the union list edited by Ranganathan. The great majority of the titles listed in this compilation have been published in the last decade; thus, readers are assured of timely and useful information on current developments in this area. The printing, the arrangement, the indexes, and the directory of Indian publishers attest to skill and care given to the preparation of this work.

T. W. MARTON
Library, National Bureau of Standards, Washington, D.C.

Gifford Pinchot: Forester-Politician. M. Nelson McGeary, Princeton University Press, Princeton, N.J., 1960. xii + 520 pp. $8.50.

To foresters the name of Gifford Pinchot means the man who, above all others, created the profession of forestry in the United States, the man who was instrumental in shaping the present system of national forests, and the man who made the U.S. Forest Service a model agency. To the conservationist, it was Pinchot who worked hand in hand with Theodore Roosevelt during the glory days of the movement. Pennsylvanians will recall Pinchot as a vigorous, effective, and honest governor who served the commonwealth for 8 years during the '20's and '30's, when vigor, skill, and honesty were far from commonplace in state administration.

This biography reviews Gifford Pinchot's life as a whole for the first time. It is a pleasure to report that Nelson McGeary, chairman of the department of political science at Pennsylvania State University, has given us a full, perceptive, and judicious account, of the sort that Pinchot was wholly incapable of writing.

Pinchot considered himself as having had two separable careers. He described his early work in forestry in the autobiographical *Breaking New Ground*; this career ended in 1910, after President Taft resolved the Ballinger-Pinchot controversy by firing Pinchot as forester. McGeary originally began the present study as a political biography of Pinchot's later years.

"Don't try any sly or foxy politics," Pinchot lectured forestry students at Yale: "A forester is not a politician." Pinchot's own life belied the distinction, at least for any forester in a position to influence public policy. McGeary found it essential to broaden the compass of his biography. The result is an illuminating study in which the several interests and activities in Pinchot's career are effectively interwoven.

Pinchot won two terms as governor despite a lack of certain political skills. Notably, he had neither talent nor taste for compromise. Yet he was by no means an unsuccessful practitioner in government, and his greatest strength in politics stemmed from an unflagging devotion to what he conceived to be the "greatest good of the greatest number in the long run." This happy phrase describes what led him to choose forestry for his profession. As a statement of the underlying objective of national forest management, Pinchot's words have become a cornerstone of public resource policy in the United States.

Pinchot was a skillful and effective administrator, drawing to the Forest

Service and later to the state government of Pennsylvania an able and dedicated corps of men. He was neither the sole creator of American forest policy nor the sole creator of the U.S. Forest Service. Yet 55 years after the Transfer Act that gave the Forest Service its present form, American forestry and the Forest Service still show his stamp. Pinchot excelled only as the chief executive of an organization. He had a chronic inability to work effectively with his peers in the Republican party and in the Progressive movement. To only one superior did Pinchot ever give the full measure of loyalty and devotion he inspired among his own subordinates, and that man was Theodore Roosevelt, with whom he enjoyed a special privileged status. This fact was largely responsible, in McGeary's judgment, for thwarting many of Pinchot's political efforts. Three times he tried unsuccessfully to win a seat in the Senate, and on other occasions he revealed almost painfully naive dreams of succeeding to the White House.

Pinchot's greatest weakness was a tendency to see issues, men, and motives in harsh black and white. He seldom doubted where Virtue took her stand. This cast of mind dimmed his perception of some ethical questions; it also left him blind to some of the plain realities of life, both in forestry and in politics. Thus, Pinchot remained a militant lifelong advocate of federal regulation of cutting practices on private forest lands, because, in his eyes, private forest management had not really changed during the three decades since he was The Forester. It was the same Gifford Pinchot who confided to his diary in May 1936 that Alfred M. Landon could be elected President that November "if I help him."

Pinchot was a prolific and candid letter writer. His voluminous correspondence was deposited in the Library of Congress shortly before his death. These letters, together with Pinchot's diary, are the major sources of this biography. McGeary has also made effective use of the extensive mass of published material dealing with Pinchot's life and times.

This biography, as McGeary expects, will probably satisfy neither the worshippers nor the detractors of Gifford Pinchot. By setting down a round, unvarnished tale of Pinchot's life, McGeary has succeeded in showing us "what kind of person he really was, what he was striving to accomplish, and what methods he used to attain his objectives." The reader is not likely to underestimate Gifford Pinchot's lasting achievements as a forester-politician.

HERBERT I. WINER
School of Forestry, Yale University

Operations Research and Systems Engineering. Charles D. Flagle, Jr., William H. Huggins, and Robert H. Roy. Johns Hopkins Press, Baltimore, Md., 1960. x + 889 pp. Illus. $14.50.

Although not explicitly advertised as such, this book is a collection of articles on the methods of operations research, written at an elementary level that is suitable for engineers and management personnel. There are introductory articles on the general philosophy and methodology of operations research and specific articles on such techniques as linear programming, queueing theory, theory of games, simulation studies, information theory, and other systems methods. Finally there is a collection of case studies. The chief defect in these articles is a tendency to verbosity on the part of some of the contributors.

By far the most fascinating and persuasive section is that on case studies. Of particular interest is an article by Zimmerman on the simulation of tactical war games; the discussion follows the course of a particular game step by step. Other articles detail studies on the operation of a hospital and a newspaper and analyze the cost and value of reports in a telephone company.

An article by Ellis Johnson (reprinted from the *Journal of Operations Research*) on operations research in the world crisis in science and technology goes far to illustrate the limitations of overenthusastic applications of operations research considerations.

This book contains little that is new, but it is a worthwhile addition to the bookshelf of management personnel and others not actively engaged in operations research work.

GEORGE WEISS
Institute for Fluid Dynamics and Applied Mathematics, University of Maryland

Miscellaneous Publications

(Inquiries concerning these publications should be addressed not to Science, but to the publisher or agency sponsoring the publication.)

U.S. Geological Survey. *Geological Survey Bulletin.* Bulletin No. 1058-E, "Geology and ore deposits of northwestern Chichagof Island, Alaska," Darwin L. Rossman, 1959, 80 pp. + maps; Bulletin No. 1061-F, "Glacial geology of the Mystic Lakes-Fresh Pond area, Massachusetts," Newton E. Chute, 1959, 31 pp. + map; Bulletin No. 1071-H, "Igneous and tectonic structures of the Stillwater complex, Montana," W. R. Jones, J. W. Peoples, and A. L. Howland, 1960. 63 pp. + map; Bulletin No. 1072-0, "Geology and oil-shale resources of Naval Oil-Shale Reserve No. 2, Uintah and Carbon counties, Utah," W. B. Cashion, 1959, 44 pp. + map; Bulletin No. 1074-F, "Geology and uranium occurrences in the Miller Hill area, Carbon County, Wyoming," James D. Vine and George E. Prichard, 1959, 41 pp. + map. *Geological Survey Professional Papers.* Paper 294-M, "Foraminifera of the Monterey shale and Puente formation, Santa Ana Mountains and San Juan Capistrano area, California," Patsy Beckstead Smith, 1960, 35 pp.; Paper 315-D, "Stratigraphy of Pennsylvanian and Lower Permian rocks in Brown and Coleman counties, Texas," D. Hoye Eargle, 1960, 25 pp. + maps; Paper 332, "Cretaceous and Tertiary formations of the Book Cliffs, Carbon, Emery, and Grand counties, Utah, and Garfield and Mesa counties, Colorado," D. Jerome Fisher, Charles E. Erdmann, and John B. Reeside, Jr., 1960. 84 pp. + maps; Paper 333, "The foraminiferal genus *Orbitolina* in North America," Raymond C. Douglass, 1960, 55 pp. + maps; Paper 334-C, "Trilobites of the Upper Cambrian, Dunderberg shale, Eureka district, Nevada," Allison R. Palmer, 59 pp.; Paper 334-D, "Late Paleozoic Gastropoda from northern Alaska," Ellis Y. Yochelson and J. Thomas Dutro, Jr., 1960, 40 pp.; Paper 351, "Mode of flow of Saskatchewan Glacier, Alberta, Canada," Mark F. Meier, 1960, 79 pp. + maps. U.S. Geological Survey, Washington, D.C. (order from Supt. of Documents, GPO, Washington 25).

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Reports

Water Permeability of Bacterial Spores and the Concept of a Contractile Cortex

Abstract. Assumption of a water-impermeable coat on bacterial spores is inconsistent with known permeabilities of organic materials. A low water content may arise through compressive contraction of the cortex during spore maturation.

Hypotheses for the heat stability of bacterial spores usually assume a low water content maintained by a water-impermeable coat. Such a coat, tenths of a micron thick, implies properties not approached in plastics technology.

A rough approximation establishes the range of maximum magnitude of time required for water equilibration within a spore immersed in water. Assume an initially dry sphere 1 μ in diameter, with moisture sorption properties of wool keratin, surrounded by a coat (0.1-μ thick) of material, such as Saran, with moisture permeability 0.0005×10^{-8} gm/cm sec cm-Hg (water vapor pressure difference). If this composite particle is immersed in water at 25°C, it can be calculated that the center will become 90 percent saturated in about 200 seconds. Since the spore coat is dominantly protein (*1*), perhaps 10^8 times as permeable as Saran, this time is probably high by several orders of magnitude. It seems clear that a water-impermeable layer on a spore requires an organic material many orders of magnitude less permeable than the best available technological materials.

Thus, hypotheses for stabilization of essential spore constituents should be compatible with rapid equilibration of all constituents with the water vapor pressure of the external environment—usually liquid water. Murrell and Scott (*2*) found the spread in heat resistance between species diminished greatly at external relative vapor pressures ("activities") below 0.9. This implies water equilibration of the sensitive volumes within the experimental periods of 1 to 6 weeks. They also showed that all the water of a moist spore cake is freely exchangeable with D_2O.

There are good reasons to think that some sort of barrier is involved in maintenance of a low water content. We have observed that spores in sparse aqueous suspension pressed under a cover slip on a microscope slide become less refractile more or less rapidly, depending upon the pressure. With moderate pressure contents are extruded. When a phase objective was racked down with just the right pressure, spores changed from light to dark (without visible change of shape) by the time the microscope could be refocused—that is, within a few seconds. *Bacillus cereus, B. coagulans, B. megaterium,* and *B. subtilis* have been studied. We believe that the phenomenon is essentially that of "mechanical germination"—simulation of physiological germination achieved through abrasion by Rode and Foster (*3*).

The hypothesis that the bare essentials of a vegetative cell—deoxyribonucleic acid and indispensable enzymes—are rendered hydrophobic or otherwise stabilized on a molecular level lacks simplicity and elegance in our view. Electron micrographs of sections of germinating spores (*4*) show that the region within the innermost membrane remains intact (and develops into the vegetative cell) while the outer coats rupture or disintegrate. This apparent integrity of a minute vegetative cell within the spore and the speed and trigger-like action of physiological and mechanical germination seem inconsistent with a stripping of covalently-bonded hydrophobic groups not only from hydrophilic materials of the outer portions, but also from the vital core. We propose an alternative hypothesis that we owe directly to a recent opportunity to hear Werner Kuhn lecture at the University of California on the reversible interconversions of chemical potential energy and mechanical work in synthetic copolymers (*5*).

We visualize an essentially familiar but minute vegetative cell within the spore, dehydrated and shrunken to about one-half the diameter of the intact spore. It is surrounded by the cortex—dense, refractile, of unusual biochemical composition (*6*), and with a wall thickness about one-fourth the diameter of the spore. The cortex is surrounded by a thin coat of protein, admixed with cell membrane material (*1*). The entire system is in water vapor equilibrium, but the water content within the interior vegetative cell is reduced and accounts for heat stability. The lowered water content is maintained by mechanical pressure upon the interior vegetative cell since a hydrated cell would have a larger volume than a dehydrated cell. Pressure is exerted by a slow contraction of the cortex during spore maturation, which serves to dehydrate both the interior vegetative-cell and the cortex itself.

The spore cortex may contract under a slowly changing chemical potential in the latter stage of sporogenesis. Concentration of calcium (and other divalent cations) in or about the cortex by active transport across a membrane surrounding the immature cortex provides an attractive possibility for a controlling chemical potential. Sections of *Clostridium sporogenes* show that the initially wrinkled (*7*) outer membranes of the sporè primordium assume a tightly stretched appearance as the spore develops. The typically ridged mature spore coat may be a device for taking up space vacated by the contracting cortex, thus enhancing the concentration of solutes of the immature cortex.

The contractile cortex, with low molecular weight components apparently not held by covalent bonds, should be a fascinating subject for experimentation. Its ready disintegration seems particularly well suited for germination. Its integrity is dependent upon the spore coat. Although the notion of water impermeability must be abandoned, it seems quite possible that the rate limitation in mechanical or physiological germination could be diffusion through the ruptured or otherwise altered coat of calcium or other small solutes. If the coat became permeable, their diffusion could be well-advanced in a small fraction of a second. Indeed, the cortex resembles a system reversibly precipitated by a high calcium ion concentration. Dipicolinate release was accelerated at 65° compared with 4°C in

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Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

abraded but not in normal spores (*3*), an effect consistent with the usual influence of temperature upon solubility product. Spore sections previously floated on 10 percent acetone in water were relatively electron transparent in the cortical region; when floated on a dilute aqueous solution of lanthanum, the cortical region was much more dense (*4*), showing a strong adsorption of the trivalent cation.

The notion of a contractile cortex unifies the problems of development and release of a low-water condition. On the other hand, the stability of the vital cores of dormant spores to heat and the development of germinated spores now do not appear more mysterious than the behavior of lyophilized cells.

The hypothesis is not grossly inconsistent with free energy requirements for dehydration and with known strengths of materials. Wool keratin may again be taken as representing the spore core. The free energy required in the change of wool with 36 percent water (equilibrated by vapor transfer with pure water) to 15 percent water (equilibrated against a salt solution with water activity 0.5) is about 1 cal/gm of dry keratin (*8*), and for complete dehydration about 10 cal. A relatively small amount of substrate should suffice for the observed dehydration of the spore even with considerable inefficiency in the contraction.

To approximate the strength required for compressive dehydration of wool to 15 percent water, we equate the pressure energy (resilience) to the free energy of dehydration: 1 cal/cm^3 of keratin = 43 kg/cm^2. (This ignores density and osmotic pressure. The pressure obtained is well above measured osmotic pressures of vegetative cells; that of the specialized spore core may be very low.) A 1-μ sphere of keratin held by a tensile coat 0.1-μ thick requires a strength of about 90 kg/cm^2; a 0.5-μ sphere with a 0.25-μ coat requires about 35 kg/cm^2. Muscle and Kuhn's copolymers (both wet) have tensile strengths of 5 to 20 kg/cm^2; rubber and plastics have strengths to 700 kg/cm^2.

We present this speculation in hope that a simple definitive test will be suggested, and also for the insights to be expected from a novel view. If sporulation involves the walling off of a minute vegetative cell *within* the cytoplasm of the parent cell (the newly germinated spore is osmotically stable), some factors involved in cell wall formation should be essentially similar in sporulation and in vegetative growth. Thus in Collier's (*9*) elegant system with *Clostridium roseum*, penicillin (an inhibitor of cell wall synthesis) inhibits an early stage of sporulation but not the conversion of dipicolinate-rich immature spores to heat-stable spores, a stage that might involve primarily the active-transport of divalent cations across the previously-formed external membrane (*10*).

J. C. LEWIS
N. S. SNELL
H. K. BURR

Western Utilization Research and Development Division, U.S. Agricultural Research Service, Albany, California

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15 July 1960

Transmissible Agent Associated with 26 Types of Experimental Mouse Neoplasms

Abstract. A transmissible agent or factor has been found to be associated with all transplanted and spontaneous experimental tumors examined. This observation was made possible by utilization of a biochemical response of normal animals when inoculated with plasma or organ extracts from tumor-bearing hosts. This transmissible enzymic "lesion" is expressed by a five- to tenfold increase in the plasma lactic dehydrogenase activity of the injected normal test animals. The factor is heat labile, passes through bacteria-retaining filters, but is nondialyzable. It is partially sedimented by centrifugation at 100,000*g* for 1 hour.

With the aid of a new technique, a transmissible factor has been detected in the blood of all animals bearing transplanted and spontaneous tumors so far examined. This includes a spectrum of 25 standard transplanted mouse tumors, and one variety of a "spontaneous" neoplasm of uncertain etiology.

The agent is detected by its induction of an abnormal enzyme response in the peripheral blood of normal test animals after injection of plasma from a tumor-bearing donor. This enzyme indication of the presence of an otherwise "silent" agent is in the form of a five- to tenfold increase of lactic dehydrogenase (LDH) activity in the recipient blood plasma. This usually appears within 48 hours and can be transmitted serially to other normal recipients apparently indefinitely.

The factor is transmitted through injection of plasma, whole blood, tumor extracts, or organ extracts from a tumor-bearing or leukemic animal. No detectable enzyme alteration or transmission occurs with similar materials from analogous normal animals or with heated materials from tumor-bearing animals. The factor may be transmitted by intraperitoneal, subcutaneous, intramuscular, or intravenous injections, or by dermal application.

Plasma, or organ extracts, from the tumor-bearing host may be employed in crude form or they may be clarified by centrifugation at relatively high speed, or passed through bacteria-impervious Selas filters of 03 porosity. Some agent was still present in the centrifuged supernatant after 1 hour at 100,000*g*, but the highest activity was associated with the resuspended pellet. The factor did not pass through standard Visking cellophane dialysis tubing which retains particulates exceeding a molecular weight of approximately 20,000.

With this simple enzymic technique, the presence and the transmissibility of the factor can be followed even though no immediate overt pathological or other physical manifestations are readily detectable when the factor is injected into adult animals.

In general, Swiss ICR male mice were used as recipient test animals for testing mouse tumors, although appropriate strains matching the requirements for tumor transplantation were also employed. However, the transmissibility of the factor crosses all mouse strain lines so far tested, so that Swiss

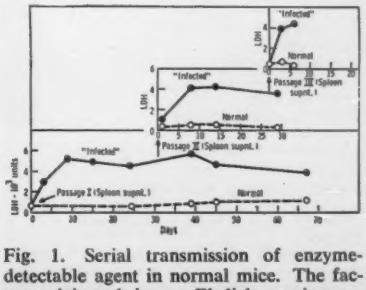

Fig. 1. Serial transmission of enzyme-detectable agent in normal mice. The factor originated in an Ehrlich carcinoma-bearing mouse and was transmitted by way of spleen extract supernatants.

mice may be used for detecting the agent from tumors that require other host strains for successful cellular transplantation.

Lactic dehydrogenase was determined by previously reported spectrophotometric methods (*1*), and serial blood samples were obtained by a modification of the orbital bleeding technique (*2*).

Figure 1 illustrates the serial transmissibility of the factor through several passages of Swiss ICR mice. In this instance, the agent was transmitted through the supernatant of centrifuged spleen extracts. The original spleen was from a mouse implanted subcutaneously with an Ehrlich carcinoma. Analogous spleen extracts from normal animals had no influence on the lactic dehydrogenase, and spleen extracts from tumor-bearing mice behaved the same as normal extracts when they had been heated at 70°C or higher for 15 minutes. The same is, of course, true for other organ extracts and for infected blood plasma.

Table 1. Serial transmission of plasma factor from a mouse implanted with the Lewis lung carcinoma through sufficient passages to dilute the original inoculation to 10^{-18}.

Passage	Mouse strain	Day*	Average plasma LDH†		Dilution‡ of original plasma
			Normal	Tumor	
1	C577BL (F)	2	370	3700	10^{-3}
2	ICR (M)	5	610	3300	10^{-6}
3	ICR (M)	4	410	3300	10^{-9}
4	ICR (M)	2	770	2800	10^{-12}
5	ICR (M)	2	360	3100	10^{-15}
6	ICR (M)	3	370	3700	10^{-18}

* Number of days elapsing between plasma injection and LDH determinations. † Five mice per group; intraperitoneal injection of 0.1 ml of infected plasma. ‡ The dilution is somewhat greater than this value (0.1 ml of 1/10 diluted plasma injected intraperitoneally into a 20-gm mouse is approximately 5×10^{-4} dilution per passage, assuming full carcass distribution).

Table 2. Typical plasma LDH values with time in normal recipient mice following injection of blood plasma from tumor-bearing mice compared with controls receiving normal plasma. There were five mice in each group. The plasma LDH ranges were similar to those in Table 3.

Tumor	Mouse strain	Average plasma LDH			
		0*	2*	7*	16*
Lewis lung carcinoma	C57BL (F)	460	3,700	8,100	6,200
None	C57BL (F)	380	370	610	740
Carcinoma 1025	AKR (F)	450	2,200	5,000	4,400
None	AKR (F)	320	260	310	350

* Number of days elapsing between plasma injection and LDH determinations.

Table 3. Spectrum of 26 mouse tumors exhibiting presence of a transmissible factor in host blood by intraperitoneal passage of "tumor" plasma to normal mice.

Tumor	Host*	Day†	Plasma LDH	
			Range	Average
None	ICR (M)	0	260– 510	380
None	C57BL (F)	0	260– 470	310
None	AKR (F)	0	400– 560	430
Sarcoma 180 (solid)	ICR (M)	4	3400–5900	4400
Sarcoma 180 (ascitic)	ICR (M)	4	2200–4400	3600
Mammary Adca EO-771	C57BL (F)	2	5800–6700	6400
Mecca lymphosarcoma	ICR (M)	3	3000–3400	3200
Miyono adenocarcinoma	ICR (M)	3	1600–2200	1700
Bashford carcinoma 63	ICR (M)	3	1700–3000	2200
Lewis lung carcinoma	C57BL (F)	2	3200–4200	3700
Carcinoma 1025	AKR (F)	2	1500–3000	2200
‡Friend virus leukemia	ICR (M)	5	2600–3800	3200
‡Friend virus leukemia (solid)	ICR (M)	2	2000–2900	2400
Cloudman S91 melanoma	ICR (M)	3	2900–4400	3700
Ehrlich carcinoma (solid)	ICR (M)	2	2000–2400	2300
Ehrlich carcinoma (ascitic)	ICR (M)	2	2400–3300	2800
Sarcoma MA 387	ICR (M)	4	2500–4000	3300
Leukemia L-1210	ICR (M)	4	3300–7800	4600
Leukemia L-4946	ICR (M)	4	2700–4600	3400
Nelson ascites	ICR (M)	4	3900–4900	4200
Harding-Passey melanoma	ICR (M)	2	1600–3300	2400
Glioma 26	ICR ((M)	2	1900–3200	3100
Lewis bladder carcinoma	ICR (M)	5	4200–5400	4500
Sarcoma T-241	ICR (M)	2	2000–3300	2700
Ridgway osteogenic sarcoma	ICR (M)	13	2500–4100	3000
Wagner osteogenic sarcoma	ICR (M)	13	2500–3100	2800
‡C3HBA mammary adenocarcinoma	ICR (M)	6	3200–4600	4000
‡Moloney leukemia	ICR (M)	4	2400–4000	3000
‡Spontaneous mammary tumors§	ICR (M)	3	2300–2900	2600

* Five mice per group. Mouse strain indicated is normal recipient but not necessarily tumor-bearing donor strain. † Number of days elapsing between plasma injection and LDH determination. ‡ Known or presumed virus-induced neoplasms. § Example of eight spontaneous tumors tested. Primary mammary adenocarcinomas arising in Swiss O'Grady females, old breeders.

Table 1 illustrates the serial transmission of the agent from another tumor type (Lewis lung carcinoma), transmitted by blood plasma only. The total dilution of the plasma at each passage is more than 1/1000, which means a theoretical dilution of the original inoculum of more than 10^{-18} after six consecutive transfers of the agent into normal animals. It would therefore appear that the agent must be replicated.

Table 2 illustrates the typical course of lactic dehydrogenase in the blood of normal mice that were injected intraperitoneally with 0.1 ml of a 1-to-10 dilution of the plasma from a mouse carrying either the Lewis lung carcinoma or carcinoma 1025. In this experiment the host strain required for the tumor was employed as detector, but similar qualitative results were obtained with the Swiss ICR strain. These data also show that the control animals receiving normal plasma were unaltered in their LDH blood titer.

Table 3 lists experimental tumors which have undergone tests for this transmissible enzyme-detectable factor. Control values are listed in the table for the various normal mouse strains employed. The data show that a five- to tenfold enzyme increase occurs in the plasma of the test mice receiving a dilute plasma injection from any of the various tumor-bearing animals. The illustrative values shown are typical of several hundred similar determinations. It may be of interest to note that no increase of plasma lactic dehydrogenase, or other abnormal alteration, was observed at any stage during mouse pregnancy. This suggests that rapidly growing embryonic or fetal tissue is distinct from malignant growth in respect to this parameter.

The possible implications of these findings to cancer etiology, diagnosis, and immunological and other rational approaches to therapy and prevention are self-evident to those inclined toward speculation. It would be premature, and possibly presumptive, however, to engage in such discussions in this brief report.

It might be appropriate, however, to discuss the aspect of these studies which has made the experimental observations possible. Heretofore, initial detection of virus, or virus-like agents, has been largely dependent upon the

production of disease, or of pathological lesions, either in the host or in cells in vitro. Likewise, searches for cancer agents have relied on manifestations of overt malignancy, probably under biologically unfavorable conditions. The finding that transmissible, replicating agents can be detected by the induction of a biochemical "lesion" in a normal host, in the form of an abnormal alteration in concentration of a blood enzyme, has apparently permitted the uncovering of agents masked or "silent" in reference to standard criteria. The tumor-producing potential of this factor is unknown at present, although it has been studied only in adult animals and for limited periods in respect to latency. The quantitative correlation of plasma lactic dehydrogenase with experimental mouse tumor growth and regression, however, is now firmly established (*3, 4*) and it seems quite clear that the transmissible enzyme elevation described here is identical to the phase-three plateau previously described as an initial part of the multiphase curve associated with tumor implantation and growth (*4*). The transmissible, enzyme-elevating factor probably also explains the failure of the host plasma lactic dehydrogenase to return to completely normal levels following tumor regression (*4*). Such a five- to tenfold abnormal elevation has persisted for periods exceeding a year following "complete" tumor regression and has been transmissible when such host plasma was injected into normal recipients (*5*).

VERNON RILEY, FRANK LILLY,
EDITHA HUERTO, DAVID BARDELL
Division of Experimental Chemotherapy, Sloan-Kettering Institute for Cancer Research, New York, New York

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18 July 1960

Effect of Pyramidal Tract Activity on Dorsal Column Nuclei

Abstract. The response of single units in cuneate and gracile nuclei to cutaneous stimulation can be modified by prior stimulation of the motor cortex of the cat. Both excitation and inhibition of these neurons can be effected via the pyramidal tract.

Direct cortical projections to various sensory nuclei of higher mammals have recently been described (*1*). Although the anatomical descriptions differ slightly, it is evident that the gracile, cuneate, and spinal trigeminal nuclei are abundantly supplied with corticofugal fibers coursing within the pyramidal tract. Concurrent physiological studies (*2*) have shown a depressive effect of central structures on peripherally evoked potentials in the dorsal root (DR reflex), dorsal column relays, dorsal column nuclei, spinal trigeminal nucleus, cochlear nucleus, and the olfactory bulb. Single unit analysis (*3*) of the spinal afferent paths and of the retina, however, have shown not only an inhibition but also an excitation from central structures. We have previously shown (*4*) that the motor cortex of the cat has both an excitatory and an inhibitory influence on cuneate neurons. Responses in some cuneate neurons could be evoked by single shocks (0.02 to 2.0 msec in duration) to the pericruciate cortex, the latencies ranging from 5 to 30 msec. Other cuneate neurons were rendered less excitable for periods of 100 to 200 msec, beginning 10 to 30 msec after a single shock or a train of shocks (300 per second) to the motor cortex. The inhibition was manifested by changes in the response properties of the affected neuron when the footpad was stimulated (decreased probability of response, increased initial spike latency

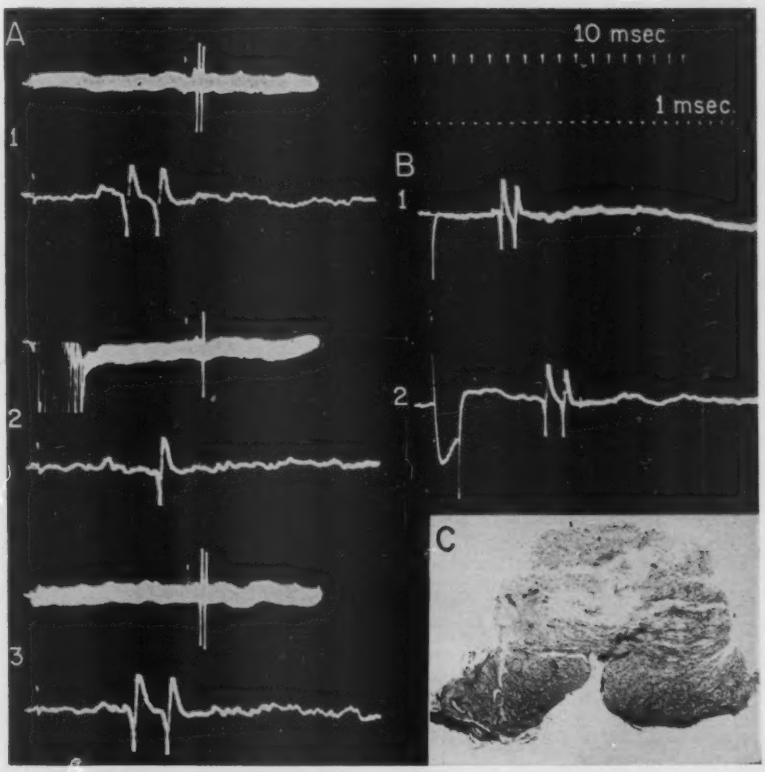

Fig. 1. Responses of two cuneate units recorded after brain-stem transection. (*A*) Inhibitory interaction. Each pair of sweeps shows same event; the upper, slow sweep was triggered 85 msec before the lower, fast sweep. Traces (1) and (3) response of unit in left cuneate nucleus to left forepaw stimulation. (2) Increased latency and decreased number of spikes per discharge to the same forepaw stimulus after a conditioning train (eight shocks at a rate of 312 shock/sec) to the right motor cortex. (*B*) Response of another unit in left cuneate nucleus to peripheral and cortical stimulation. (1) Fired by ipsilateral forepaw shock. (2) Fired by shock to right motor cortex. The 1 msec time trace applies to the fast sweeps in (*A*) and all sweeps in (*B*). (*C*) Luxol-fast section of what remained of the pyramidal tract after transection. Note that lateral borders of the pyramidal tract are damaged (× 17).

and fewer spikes per discharge). Both cerebral hemispheres displayed these modifying capabilities, although the cortex ipsilateral to the unit under observation was uniformly less effective than the contralateral cortex.

In this study (*5*) cats were anesthetized with Nembutal and paralyzed with decamethonium bromide (or Flaxedil). Single units in the cuneate and gracile nuclei were isolated by conventional 0.5 to 1.5 μ micropipette techniques. Responses in these units were evoked by needle electrodes in the footpads. Because it is not possible to excite only pyramidal tract elements in the intact nervous system, the bulb was isolated from the midbrain so that only the pyramidal tract was intact. The brain stem was exposed by a ventral approach, and the tissue was removed by suction under direct vision. The transection was begun on each side of the pyramids at the level of the trapezoid body and carried through to the bony tentorium. All tissue, including the middle and the superior cerebellar peduncles, was carefully removed so that there was a gap of a few millimeters between the rostral and caudal stumps of the transected brain stem. Bipolar silver-ball electrodes were then placed on the pericruciate cortex of each hemisphere for excitation of corticofugal elements; only the pyramidal tract, however, could carry activity beyond the transection. At the end of each experiment the brain was perfused with formalin, removed, sectioned, and stained in order to assess the extent of pyramidal tract isolation (Fig. 1*C*).

In spite of this radical surgical intervention, units in the dorsal column nuclei were affected by stimulation of the motor cortex to the same extent as were those in intact preparations. Nearly one-third of the units could be driven and two-thirds could be inhibited from the cortex; occasionally, a unit which could not be affected was isolated. Figure 1 shows the responses of two units, the first inhibited and the second driven by the motor cortex. The histological section shows the extent of pyramidal tract that remained in this animal; examination of other sections revealed nearly complete destruction of the overlying medial lemniscus-trapezoid complex, which can be seen in Fig. 1*C*. The remaining brain stem was totally transected. Evidently both excitation and inhibition can be transmitted to the bulb by way of the pyramidal tract. The excitatory effect appears to be direct. This is deduced from the following of high stimulus frequencies (in excess of 100 per second), the brief latency and the small latency dispersions found in some cortically driven units, and the profound difficulty of demonstrating excitation when the pyramidal tracts alone were transected. The inhibitory pathway, on the other hand, appears to be less direct. Perhaps the pyramidal tract projections to the reticular formation (*6*) are involved; certainly inhibition remains, albeit with altered characteristics, after transection of the pyramidal tract. Nevertheless, it is interesting that both anatomical and functional evidence points to a direct connection between the somatic motor and sensory systems via that phylogenetically recent system, the pyramidal tracts.

S. J. JABBUR
A. L. TOWE

Department of Physiology and Biophysics, University of Washington School of Medicine, Seattle

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31 May 1960

Hormonal Induction of Vascular Tissue in Tobacco Pith in vitro

Abstract. The direct addition of indole-3-acetic acid into sterile-cultured stem pith sections of *Nicotiana tabacum* through inserted glass pipettes has induced cell division and differentiation where such activity would not normally occur. This evidence lends support to the theory that indole-3-acetic acid is the hormone that limits xylogenesis.

There is considerable evidence that indole-3-acetic acid (IAA) plays a major role in the differentiation of vascular tissue in plants. The classical study of Jacobs (*1*) illustrated that vascular tissue can be induced around a wound in vivo when the original vascular strand has been severed and external IAA is introduced through a petiole in the node above the wound. Other workers (*2*) have demonstrated in vitro that vascular tissue can be induced in undifferentiated callus tissue either by grafting a bud into the callus, thus providing it with hormones diffusing from the apical tissue, or by applying indole-3-acetic acid or naphthaleneacetic acid in a lanolin paste into an incision in the callus. Pith tissue which is, essentially, undifferentiated parenchyma presents a region which has a definite orientation in the plant as opposed to the nonpolar orientation of callus. Previous work (*3*) has shown that no vascular tissue was induced in sterile cultures of tobacco pith sections when the culture medium contained only IAA as the growth-promoting substance. In fact, no cell divisions were initiated at any concentration of the hormone. Since it was shown that division could be induced with mixtures of IAA and other growth-promoting substances, the supposition was that, although IAA may cause differentiation, another growth-promoting substance is necessary to promote cell division.

The experiment described in this report is part of a study designed to give quantitative and qualitative evidence of the amount and type of differentiation induced in response to IAA and other differentiation factors in undifferentiated tissues. The observations were made during a study of the response of tobacco pith to IAA supplied through glass pipettes inserted directly into the center of the tissue (Fig. 1). Pith cylinders were removed from *Nicotiana tabacum* by boring through lengths of stem with a sterile cork borer slightly smaller in diameter than the entire pith cylinder. The pith sections were cut into 15 mm pieces and, after insertion of Pyrex glass pipettes into the morphological apical end, were placed in culture tubes containing agar-solidified Riker's tobacco medium (*4*), a nutrient mixture which contains no IAA and does not support growth of the pith. The pipettes were filled with the additives through holes pierced in the polyethylene caps that cover the tubes. The caps were sealed with small squares of cellophane tape. The pipettes were refilled as they emptied. The cultures were maintained in a culture room at 25°C with a 12-hour light-dark cycle to a maximum of 42 days, some sections being terminated each week and fixed for sectioning. In the present experiment the concentration of hormone supplied to the tissue was 0.5 mg/liter. Control cultures were set up with pipettes that contained sterile water or nothing.

The results indicate that no cell divisions occurred until the tissue had been subjected to a prolonged exposure to IAA, for no divisions were observed

before 32 days in culture. At that time longitudinal sections of the fixed tissue revealed small areas of dividing cells directly under the pipette incisions (Fig. 1). Contrary to what was expected—that is, that long files of xylem would be differentiated as in Jacobs' study—xylem tracheids were found in a haphazard arrangement among the dividing cells with occasional spherical areas of a more organized arrangement. This compares favorably with the findings of vascular tissue arrangement in callus tissue. Apparently, when pith is removed from the physiological orientation of the plant it loses its polarity and reacts basically in the same way as the nonpolar callus tissue. Since divisions were restricted to the area close to the site of the pipette insertion, it may be that there is no basipetal transport of auxin in the pith. On the other hand, this may mean merely that a relatively long period of time in culture is necessary for basipetal vascular differentiation. The latter possibility seems more likely since the sections cultured for 42 days had a much wider and longer extension of the dividing and differentiating area than the sections cultured for 32 days. The possibility that cell division was initiated by a wound hormone response was obviated by the fact that no divisions occurred in the controls. These experiments are at variance with results of previous work in which it was shown that cytokinesis and differentiation did not occur in pith sections placed on an IAA-containing medium (*3*), but did occur when the medium contained kinetin as well as IAA (*5*). It is possible that the effect of IAA on the tissue is determined by the method of application. Thus, a direct application (as through the pipettes) of IAA rather than diffusion from the medium may be necessary for cell division.

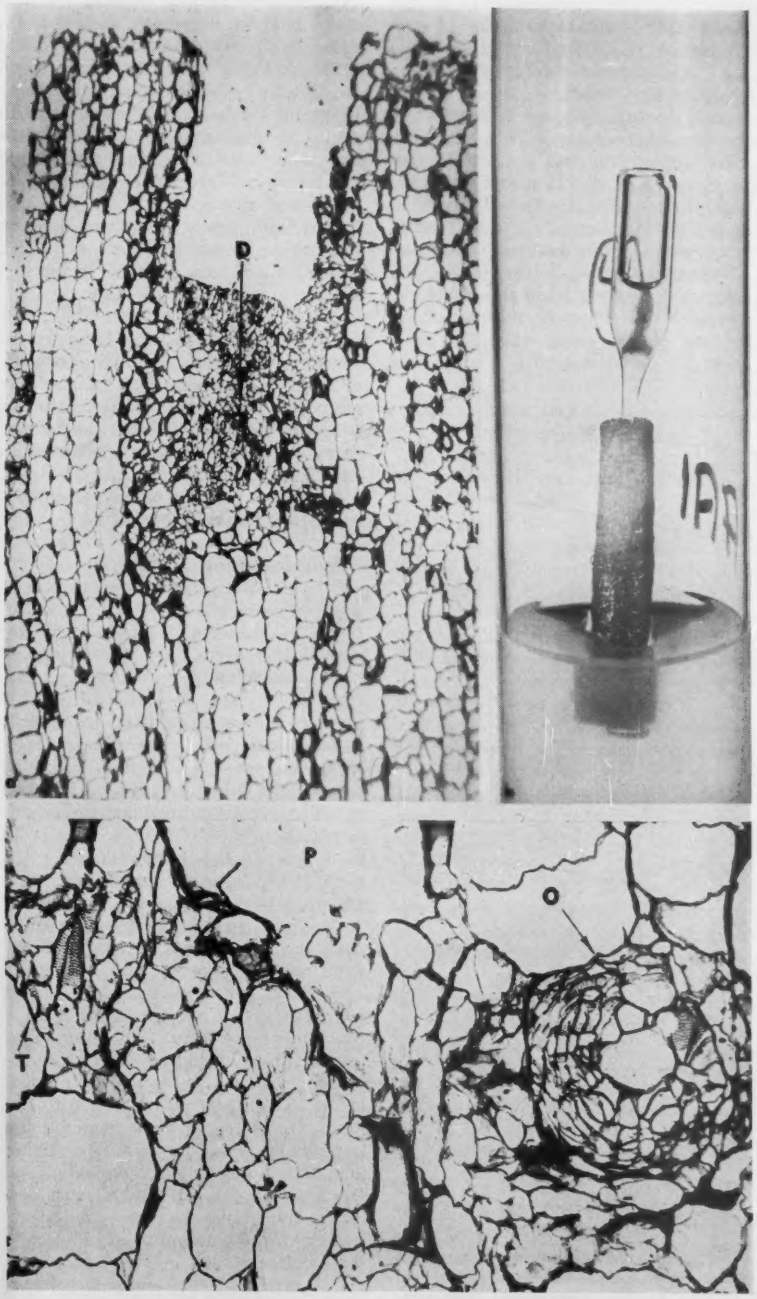

Fig. 1. (*a*) Longitudinal section of tobacco pith subjected to IAA treatment for 42 days (× 14). (*b*) Pith cylinder with pipette in place (× 1.1). (*c*) Longitudinal section of tobacco pith subjected to IAA treatment for 32 days (× 54). *P*, pipette incision; *D*, area of cell division; *T*, tracheids; *O*, organized area.

On the basis of the foregoing results it was concluded that vascular tissue can be induced in undifferentiated pith sections by the addition of IAA alone as the division-initiating and differentiation factor, provided an extended period is given in culture. Other experiments are being conducted to test this hypothesis as well as the effects of other growth-promoting substances and differentiation factors (*6*).

MARY E. CLUTTER
Department of Biological Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania

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18 May 1960

Oxygen Equilibrium of Brachiopod Lingula Hemerythrin

Abstract. In contrast to hemerythrin from five different species of sipunculid worms, ecardine brachiopod *Lingula* hemerythrin has an oxygen equilibrium which is reversibly altered by *p*H changes, both the oxygen affinity (Bohr effect) and the interactions between oxygen-binding centers being a function of *p*H. The significance of these phenomena is discussed in view of the phylogenetic distribution of hemerythrin and the function of respiratory pigments.

The distribution of the respiratory pigment hemerythrin is phylogenetically interesting. This nonheme iron-containing equivalent of hemoglobin is found only in the phyla Sipunculida, Annelida (one species), Priapulida, and Brachiopoda (*1*). Only the first two of these phyla are related, the priapulids being considered as relatives of the rotifers and nematodes, and the brachiopods being closest to the other lophophorate phyla, the phoronids and ectoprocts (*2*). Consequently, it can be asked how closely the various hemerythrins resemble one another (*3*).

Specimens of the brachiopod *Lingula unguis* were carefully dissected so as to obtain the small amount (¼ ml) of coelomic fluid with a minimum of contamination. The hemerythrin-containing "erythrocytes" were washed repeatedly in isotonic saline, differentially centrifuged each time so as to remove other coelomic cells. Erythrocytes were hemolyzed in 5 to 10 volumes of distilled water; centrifugation and filtration of the hemolyzate resulted in a clear solution of 2 to 4 percent hemerythrin. Concentrated potassium phosphate buffer was added to bring the ionic strength to 0.2 and the *p*H to the desired level (6.5 to 8; the pigment is unstable at *p*H values much above 8).

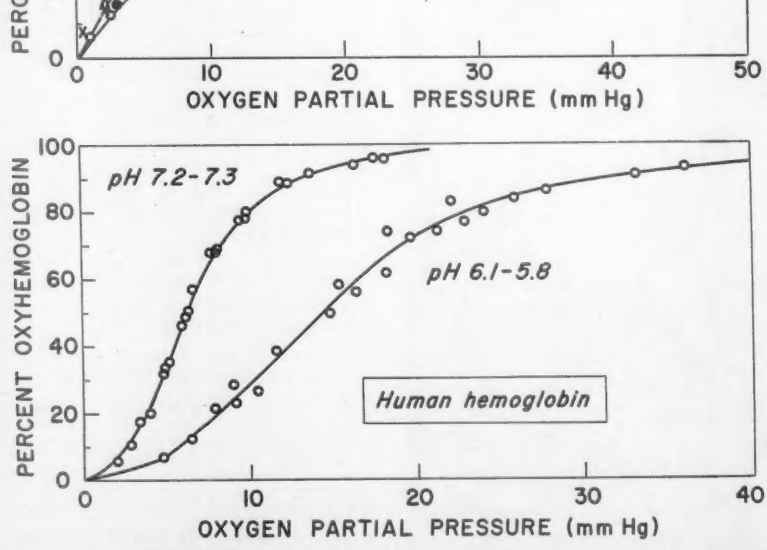

Fig. 1. Oxygen equilibrium curves for *Lingula* hemerythrin (top) and human hemoglobin (Hb A) (bottom). Temperature, 22° to 24°C; potassium phosphate buffer, ionic strength approximately 0.2; hemerythrin concentrations, 2 to 3 percent; hemoglobin concentrations, 7 to 15 percent. Reversibility of Bohr effect of hemerythrin is demonstrated by bringing sample (O), originally at *p*H 6.77, to *p*H 7.63 (△) and back again to *p*H 6.74 (●); control experiment is a second sample whose oxygen equilibrium is determined at *p*H 7.65 (X).

Oxygen equilibria were determined with a Beckman model DU spectrophotometer as described in other hemerythrin studies (*4*, *5*). To insure that any effects of *p*H change on the oxygen equilibrium represent reversible changes characteristic of the Bohr effect and not irreversible changes resulting from mild denaturation of the protein, it was customary to bring the sample to a different *p*H by the addition of dilute HCl or K_3PO_4 after the first oxygen equilibrium experiment, to determine again the oxygen equilibrium, then to return to the original *p*H, and follow this with a third oxygen equilibrium determination. Most experiments were performed at room temperature (22 to 24°C), although a few were done at 9°C with essentially similar results, except, of course, for a higher O_2 affinity.

Data on the oxygen equilibrium of *Lingula* hemerythrin are presented in Fig. 1 at two different *p*H's; for purposes of comparison, data are also presented on human adult hemoglobin at two different pH's (*6*, *7*). It can be seen that *Lingula* hemerythrin possesses a "normal" Bohr effect at physiological *p*H's that is approximately two-thirds of that for human hemoglobin. Coelomic hemerythrins of the sipunculids *Sipunculus nudus* (*8*), *Golfingia gouldii* (*9*), and *Phascolosoma agassizii* (*4*) have no Bohr effect. I have found (*5*) that the sipunculids *Dendrostomum zostericolum* and *Siphonosoma ingens* have biochemically distinct hemerythrins in the coelom and in the separate tentacular main contractile vessel circulation. None of these pigments possess a Bohr effect, although the oxygen affinities of coelomic and vascular hemerythrins can be very different. Besides a Bohr effect it can be seen that at the more alkaline *p*H's *Lingula* hemerythrin has distinct interactions between oxygen-binding centers — $n = 1.7$ to 1.8 (*10*); at the more acid *p*H's n approaches 1.0. Like the Bohr effect this is a completely reversible phenomenon. Reversible changes in the magnitude of n as a function of *p*H have been observed in teleost fish (*11*) and turtle (*12*) hemoglobins, the latter behaving in a manner identical with *Lingula* hemerythrin. For the various sipunculid hemerythrins some have small oxygen-affine center interactions (*Golfingia*, *Sipunculus*, and *Dendrostomum*) and others have perfectly hyperbolic oxygen equilibrium curves (*Siphonosoma* and *Phascolosoma*); in no case are the interactions *p*H dependent. Hence, *Lingula* hemerythrin differs significantly from sipunculid hemerythrins in this respect also. Unfortunately no data are available on the oxygen equilibria of priapulid or

polychaete *Magelona* hemerythrins. The data on *Lingula* hemerythrin oxygen equilibria indicate that a single proton-binding group whose *p*K changes from 7.9 to 6.5 upon oxygenation controls both the oxygen affinity (that is, determines the Bohr effect) and the strength of the interaction between the oxygen-binding sites [the theoretical considerations and calculations for human hemoglobins are in press (*7*)]. This proton-binding group is most likely an imdiazole group of a histidine residue that is not present in such a critical position in sipunculid hemerythrins.

The fact that *Lingula* hemerythrin has a fairly low oxygen affinity, a somewhat sigmoid oxygen equilibrium curve, and a Bohr effect is of interest from the standpoint of respiratory pigment function, for observations on the living animal indicate that frequently the pigment must serve in oxygen storage as well as in oxygen transport. As the coelomic fluid is circulated into the translucent peduncle, it is possible to obtain a measure of the degree of oxygenation of the blood by the intensity of color in the peduncle of a particular animal. It was found that 20 to 30 percent of the time the blood was colorless; that is, the hemerythrin was completely deoxygenated. Hence, apparently during periods when respiratory and feeding activity are stopped the oxyhemerythrin in the coelom gives up the oxygen and becomes completely deoxygenated.

Conceivably such an arrangement of oxygen storage might be significant in an intertidal animal such as *Lingula*, a form that withdraws quickly into its coral sand or mud burrow when disturbed. However, these properties of low oxygen affinity, oxygen-binding center interactions, and Bohr effect are exactly what Wald (*13*) has postulated as representing the epitome of the evolution of respiratory pigments—blood gas transport pigments that are correlated with high metabolic rate and activity—for example, in mammals and cephalopods. Figure 1 indicates the similarity between human hemoglobin and *Lingula* hemerythrin in so far as oxygen equilibrium is concerned. Therefore, that *Lingula*, a genus of animals essentially unchanged since Precambrian times, can evolve the same properties of the oxygen equilibrium as are found in squid hemocyanins and mammalian hemoglobins adds further doubt to the validity of Wald's (*13*) speculations. The hagfish *Polistotrema stouti* (Lockington), a representative of the most primitive group of living vertebrates, has a hemoglobin that possesses all three of Wald's "primitive" properties—high oxygen affinity, no heme-heme interactions, and no Bohr effect. However, as I have pointed out (*1*, *14*), this does not necessarily prove Wald's theory. The properties of hagfish hemoglobin are very likely the result of selection pressure favoring the development of a hemoglobin with high oxygen affinity and no Bohr effect, for the combination of mud-dwelling and almost endoparasitic habits of the myxinoids must frequently expose hagfish to situations of high carbon dioxide and low oxygen concentrations. By way of constrast, hemoglobin from the equally primitive lampreys displays a low oxygen affinity, very large Bohr effect, and, under certain conditions, slight heme-heme interactions (*15*). Lampreys remain outside the bodies of their hosts and, as adults, are very sensitive to low oxygen or high carbon dioxide concentrations. At present it is more suitable to explain the properties of hagfish and lamprey hemoglobins as adaptations to particular environments and habits rather than as indicating that any particular set of biochemical characteristics of respiratory pigments is "primitive."

Similarly, whereas *Lingula* hemerythrin possesses none of Wald's three oxygen equilibrium properties of a "primitive" respiratory pigment, various sipunculid hemerythrins, except for *Dendrostomum zostericolum* vascular hemerythrin, which has a low oxygen affinity (*5*), have all three of the basic properties. One cannot regard sipunculids as phylogenetically any more or less primitive than brachiopods; in addition, it is impossible to decide whether the occurrence of hemerythrin in both phyla represents relationship or convergence, though *Lingula* hemerythrin is quite different from all known sipunculid hemerythrins in its oxygen equilibrium properties. Accordingly, just as for hemoglobin, it is apparent that for hemerythrin there is no reason to assume any particular set of oxygen equilibrium properties is "primitive"; in addition, the set of oxygen equilibrium properties that is observed for a particular pigment can be often correlated with the ecology and physiology of the particular animal (*16*).

CLYDE MANWELL

Department of Physiology, University of Illinois, Urbana

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$$y = 100\ (p/p_{50})^n/[1 + (p/p_{50})^n]$$

where p_{50} is the oxygen partial pressure at which the pigment is 50 percent oxygenated and n is a measure of the interaction between oxygen-binding sites on the same molecule. If $n = 1.00$, the sites are totally independent; $n > 1$ indicates positive interactions between oxygen-binding sites. If $n < 1$, the interactions are negative (hindering) and the above equation fits the data poorly; slight deviations from the Hill approximation are seen when for a multiheme hemoglobin oxygenation of each site (heme) progressively increases the affinity of the remaining unoxygenated sites.
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16. The wide range of internal oxygen tensions at which oxygen transport occurs in annelid worms is quite nicely correlated with the varied properties of the oxygen equilibrium curves; see, for example, C. Manwell, *J. Cellular Comp. Physiol.* **53**, 61 (1959), or *Comp. Biochem. and Physiol.*, in press.

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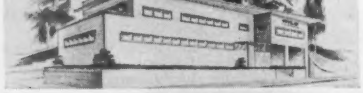

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Letters

Teacher Training

Having been involved as a member of the curriculum committee of the State University of New York College of Education at Cortland in a recent revision of our curriculum for the preparation of elementary school teachers, I was interested in the report by John Mayor of the proposals coming from a meeting of representatives of the AAAS and various certification groups from several states [*Science* **131**, 1779 (1960)]. May I suggest that it is an admirable aim to require four courses in mathematics for all prospective elementary teachers, but that this is unrealistic as long as students come to college so poorly prepared in even basic arithmetic, and unreasonable unless the AAAS and other groups concerned in this matter are willing to give wholehearted support to the upgrading of teachers' salaries and professional standing. If our students came to college able to handle the mother tongue and having learned their lessons in basic science, social studies, and so forth, it might be possible to eliminate what is really remedial work in the colleges and thus gain time for teaching these recommended and truly collegiate courses.

It is clear in my mind that we cannot hope to adequately prepare a person to teach in the elementary school in the usual four years of college. If scientists and engineers are born and nurtured in the elementary schools of our land, then elementary school teachers must be ready to play the vital role assigned them. If this requires four courses in mathematics, then it also requires eight courses in science, to say nothing of foreign language, now almost forgotten in the preparation of elementary teachers. Then must come English, speech, music, art, sociology, history, psychology, philosophy, health, political science, and the necessary pedagogical courses. Physical education must not be neglected, and every teacher needs apprentice teaching experience. No college program should eliminate the possibility of electives. What this all adds up to is at least five years of college work, if not more. When this is balanced against potential pay and prestige, is it any wonder our best prospects turn their backs on teaching?

In our curriculum study here each department brought its recommendations for those courses considered essential in the training of elementary school teachers. From this immense total was carved a compromise which would total the 132 semester hours required for graduation. No one is happy with the result, but compromise is the best that can be done. As a liberal-arts college graduate sympathetic to the recent cries against "too much professional education in our teachers colleges," may I say that I believe the 21 hours (equal to seven courses) in pedagogy, including 3 hours in general psychology and 6 hours in human growth and development, which are included in our curriculum are an absolute minimum. The only way that an adequate job can be done is to lengthen the course of study. The recent five-year programs started at some engineering colleges are attempts to cope with the same problem. These are things of which scientists cooperating in these studies must be aware.

JOHN A. GUSTAFSON
State University College of Education, Cortland, New York

The Scientist's Image of Himself

Gerald Holton rightfully points out [*Science* **131**, 1187 (22 Apr. 1960)] the schism that exists between scientific knowledge and other currents of intellectual thought. Although he suggests that scientists themselves contribute to this schism, his major emphasis is on the image that the public has of science, and of the scientist. I think that the images scientists hold of themselves, and particularly the changes that are evident in their self-representations, also play a very significant role.

I had an opportunity to investigate the self-images of 40 research scientists, men in natural-science fields at academic installations, as one part of a larger psychological study of persons who have selected research science as their vocation. The findings brought out that in some aspects of their identification scientists are caught up in some of the sterotypes about men of science that exist in the public mind. For example, they see themselves as intellectuals, as discoverers of new worlds—worlds which they not only create but in which they then proceed to live. Their work is propelled primarily by pressing "inner" drives; thus, the majority scorn "impure" motivations, such as the desire for recognition, exhibitionism, personal aggrandizement, pragmatic reward, unless these are inescapable concomitants of devotion to the search for truth. Happiness and fulfillment rest primarily in satisfactions at work, with routine, drudgery, administrative duties played down as interferences. In fact, rigor, persistence, and discipline have become institutionalized in their morality code as values in themselves, and the "gentleman scientist" is looked down upon as a laggard who is bound to be unproductive.

It is obvious that such facets of identification emphasize how isolated the researcher is, and how removed from the general cultural pattern. However, he shares many of the elements that would establish bonds between men of science and other intellectuals. Where the break with the intellectual comes is in some of the aspects of identification which are in the process of change, and where some of these most highly stereotyped conceptions about scientists are giving away.

Change in self-image seems to have been most stimulated by the differences that have emerged in the way science is pursued, and the attitudes and values that have accompanied these differences. I shall mention only a few to show the trends of change. For one, the researcher is now shying away from identification with the "great, but maladjusted" or "eccentric" scientist. Reverence for forefathers whose outstanding minds were sometimes housed in odd personalities still exist, yet today's scientists consciously dissociate themselves from peculiar and difficult associates or students, knowing full well that they may be shunting off some very creative workers from their own laboratories. They prefer to depend for their progress on a well-organized, smooth-running, large-scale operation, whose stability demands a minimum of interpersonal relations, especially disturbed ones. Even colleagues who "play expert" in nonscientific fields and attempt to generalize scientific knowledge in relation to cultural problems are frowned upon, and often their scientific work is looked upon retrospectively with suspicion.

Another change comes in the new interest in "putting breakthroughs across." While these men still stress that the main motivation of scientists is the gaining of understanding and knowledge without concern for its immediate application, they feel that the fruits of their searches can be more readily put to good use if they adopt what I have called the skills of "sciencemanship." Some think that success in science and the manipulation of that success are a natural sequence, if one realistically acknowledges that the same motivations which are found in other workers are also present in scientists—such as jealousy, competition, the desire to please a superior.

In general, the new model of science is a corporate one. With this, and its spelling out of all the multiple subparts, budgets, and personnel and administrative matters, comes an increasingly tight definition of what each scientist specifically does at work. This is an important change in the scientist's view of his role, which has characteristically been in part ambiguous and indefinite, hinting at the possibility of multiple choices. Many scientists have

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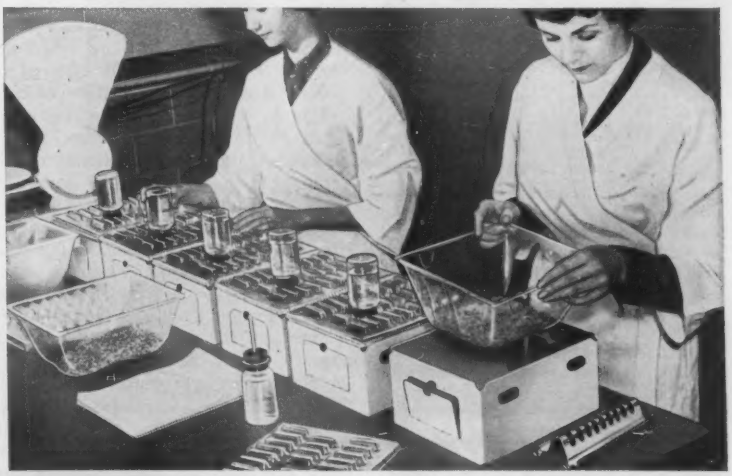

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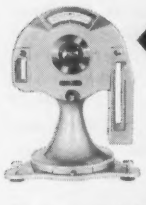

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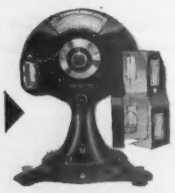

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clung to this ambiguity because it seemed to them to mirror some of their attitudes toward the intellectual problems with which they grappled—their dissatisfactions with the obvious and with conventional ways of seeing reality.

It seems to me that these changes in self-image imply that the scientist may be moving outside the intellectual pale and that he thus may remain quite unconcerned with the cultural schism that Holton points out. The "impotence of the modern intellectual" has a counterpart in the impotence of the modern scientist. If the intellectual is moving away from the scientist and the scientist is, at the same time, moving away from the intellectual, the summation would indicate that the two may be drawing apart at an alarming rate.

BERNICE T. EIDUSON
Reiss-Davis Clinic for Child Guidance, Los Angeles, California

Bernice Eiduson's letter is a useful amplification of some points on which I only touched in my article. Because the latter was largely on the image of science and of the scientist in the mind of the literary intellectual, it did not attempt to develop also the interesting problem of the scientist's own image of his work and profession.

There are, I think, at least three good reasons why one should be careful to discuss these problems separately. I cannot develop them here, but I can mention them briefly.

The first point is simply a practical one. Imaginative remedial action is quickly needed on both fronts, but urgency for action is all too often destroyed if each "side" is allowed to make the comfortable mistake of cancelling its obligation by detecting equal needs of reform on the other "side."

Secondly, the two problems are not compatible in an important sense: It is, as Dr. Eiduson implies, bad enough if scientists have an erroneous conception of the nature of science; but it is even worse if this is the case of intellectuals outside science, for we have always depended on the latter to fit science into the total pattern of knowledge. It is not the Newtons who give us Newtonian syntheses but the Voltaires.

Lastly, even at the risk of being widely misunderstood, I feel I must point out that the two problems are unsymmetrical: despite Dr. Eiduson's uncomfortable findings on 40 scientists, the general policy and the tone of scientific work in this country are still being set by men and women who give us far more and far better statesmanship than we might have any right to hope for. Just as in my article I was concerned with the image of science in

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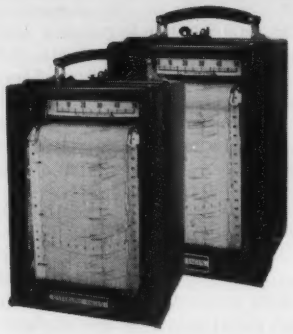

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the minds of the intellectual leaders to whom the public looks for guidance, I find it significant that among the leading scientific policy makers we still have the quality, insight, and range of concerns of such men as Rabi, Szillard, Oppenheimer, Bronk, Wiesner, Stratton, Kistiakowski, Beadle, Harrison Brown, and Glen Seaborg, to name only a few at random.

Perhaps, however, this hopeful aspect of present scientific leadership is only transitory. These men received their training in the days before the "new science." If the concerns of the new generation of scientists fit those expressed in Dr. Eiduson's sample, one may indeed wonder what will happen when the men and women she studied take the place of our present spokesmen for science.

GERALD HOLTON
Department of Physics,
Harvard University

Computers and Game-Playing

Since *Science* is intended not only for scientists in general but also for intelligent and interested laymen, it seems unfortunate that Norbert Wiener [*Science* **131**, 1355 (1960)] should have permitted himself to use the jargon of computer specialists without any explanation of the special meanings which accompany this jargon. Wiener discusses checker-playing machines, chess-playing machines, and learning machines, and this may give the impression that these are actual physical embodiments of such abilities. Actually, no such machines exist. Wiener has here followed the practice of discussing a program on a general-purpose computer as though it represented a special-purpose machine which would operate in the manner set forth in the program.

A program is a set of numbers in a certain order, and without human interpretation it remains only that. Undoubtedly a machine could be built which could move checkers and chessmen, but it could only operate on standard-size pieces and could not recognize as chessmen the innumerable pieces of different design which the human player recognizes and moves around quite simply.

It is also possible to play abstract chess, like games in a book, without moving pieces physically; but there are analog relationships in real chess—for example, the emptiness of a line, which is the requirement for movement or castling—which cannot be directly handled by any digital machine. These analog relationships can be approximated digitally by remembering and recalculating the moves of all other

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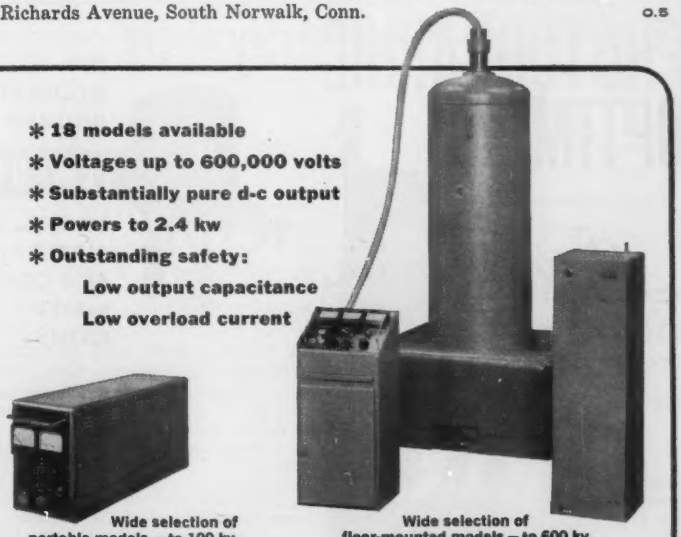

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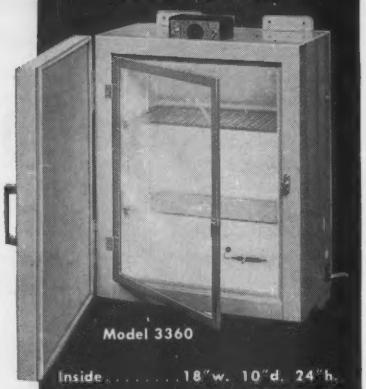

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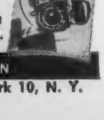

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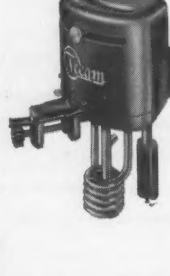

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pieces in order to determine whether a given line is empty and, hence, that a certain move is possible. But such a set of calculations is not identical to the visual recognition that the space between two pieces is empty. A large part of the enjoyment of chess—for example, its relationship to war games—derives from its deployment or topological character, which a machine cannot handle except by elimination. Wiener recognizes this problem by noting that different programs would be required for opening, middle, and end games. If *game* is used in the usual sense—that is, as it was used before the word was redefined by computer enthusiasts with nothing more serious to do—it is possible to state categorically that machines cannot *play* games. They cannot *play* chess any more than they can play football.

In Wiener's earlier work, *Cybernetics*, he was able to make a case for learning machines only by equating learning with conditioned reflexes. As a matter of fact, the doctrine of conditioned reflexes as an explanation of human habits and human learning is certainly questionable, if not false. Sherrington can be accepted as an authority in stating that although the behavior of living organisms can be modified by subjecting them to certain patterns of experience, reflexes in the physiological sense of that term are not conditionable or modifiable. In short, the expression *conditioned reflex* is a contradiction, because physiologists distinguish reflex activity from other types of nervous activity on the basis of the fact that reflexes cannot be conditioned. There is nothing more strange or mysterious in this fact than there is in the denial of the Lamarckian doctrine of the inheritance of acquired characteristics. Sherrington explicitly and categorically distinguishes reflex behavior from habitual behavior on the grounds that habitual behavior is acquired and modifiable, whereas reflex behavior is not.

Having described the feedback operations of computers in *Cybernetics*, Wiener goes on to say: "I wish to emphasize that I do not say that the process of the conditioned reflex operates according to the mechanism I have given; I merely say that it *could* so operate. If, however, we assume this or any similar mechanism, there are a good many things we can say concerning it. One is that this mechanism is capable of learning. It has already been recognized that the conditioned reflex is a learning mechanism. . . . There is nothing in the nature of the computing machine which forbids it to show conditioned reflexes."

When reputable scientists begin to accept explanations merely on the basis that they *could* be true and that nothing

forbids their being true, science becomes indistinguishable from superstition.

One final comment should be made about the danger of heuristic arguments about heuristics in science. Wiener objects to von Neumann's theory of games, which depends upon stating the complete formal rules of a game, and suggests that we substitute tentative play modified by experience. He justifies this suggestion by pointing out that this is the way human beings play chess, in particular, or run their affairs, in general. He points out that certainly Napoleon won his victories by modifying his strategies in terms of the different abilities and responses of his opponents. He seems not to recognize that this strategy also led Napoleon to Russia and Elba.

MORTIMER TAUBE
Documentation Incorporated, Washington, D.C.

Science and Human Affairs

The AAAS Committee on Science in the Promotion of Human Welfare should be congratulated on its statement [*Science* **132**, 68 (8 July 1960)]. Most of us will agree that the problem discussed is real and urgent. No one should oppose the suggested preparation and dissemination of reports for the general public.

The "development of liaison between scientists and the public on a local basis," however, raises some prickly problems and should stir up a continuing debate. The scientist who tries to take part in political and economic activities as a scientist, instead of merely as a citizen, comes face to face with the fact that all important decisions in business, politics, and war are made on the basis of inadequate information and unproved theory; in an embarrassingly large number of cases, the scientist can only point out the depth and breadth of human ignorance—and shut up. But in many cases the border line between personal prejudice and scientific theory is pretty dim, and the man who sets out to explain the facts about radioactive fallout or increasing birth rates is apt to find himself defending a political philosophy or religious dogma.

Unfortunately, it is a general rule that men tend to be radicals in fields which they know well and conservatives in areas where their knowledge is superficial. Physical scientists and engineers are usually classed as reactionaries by the more original theorists of politics and economics. It would be unfortunate if our efforts to serve humanity merely resulted in identifying science with the most archaic,

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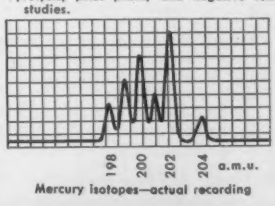

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unimaginative, and sterile approaches to social problems. (Note: I am a physical scientist.)

We can avoid such traps if—and only if—we emphasize the fact that the real contribution which science can make to problems of human relationships is *not* "facts" or "answers." The real contribution is an attitude and a set of values. Science did not gain its present power and influence simply by being an orderly accumulation of data; a large telephone directory may contain a million facts, in perfect order, and an infinite number of telephone directories would contain an infinity of factual information—and be of no value whatever for solving our major problems. Science, as we now know it and value it, exists because there have been men with a passion for ideas, whose first loyalty was to intellectual honesty—men who valued an increase in understanding more than they valued the comfort and safety of accepted authority. They have created a tradition of objectivity, tolerance, free speculation, patient analysis, and open communication. They have fought, when necessary, for the right to consider alternatives to established dogma and the freedom to discuss ideas, including the ideas of other men in other countries.

There is little doubt that such an attitude, if widely understood and generally accepted, could be a major step toward the better ordering of human affairs. I recognize the fact that there are many who will argue that the application of the scientific attitude to social relationships is impossible—that the human animal simply has to have some outlet for the irrational and psychopathic forces which are within us all. It is obvious that we all seek someone to blame for our frustrations and inadequacies. There is something irresistibly attractive in the thought that we can please God and solve all problems by simply burning heretics and despoiling unbelievers. War, politics, and religion have traditionally satisfied these needs, and it may be argued that they always will. We can only say that, if this is so, "always" may be a very short period of time. But we have good reason to hope that there are unexplored potentialities in human psychology. Books like Ruth Benedict's *Patterns of Culture* tell us that there are alternatives to most of the sources of satisfaction which we take for granted, and that enduring societies can be based on these alternatives. It is not absurd to try to create a world in which scientific discovery will give as much emotional satisfaction—and bring as much prestige—as killing large numbers of strangers, or one in which intellectual integrity will be as powerful as fanaticism.

To explain, apply, and defend our scientific values is neither easy nor safe, however—especially when we try to apply them to controversial policies. The committee report ably, but too briefly, points out the pressures which are being applied to make science an instrument of national policy, and to make it sacrifice its best traditions in the hope of transforming it into a dependable military weapon. The committee might well have added some comment on the informal social pressures, which can be equally strong and equally deadly. The fact is that most laymen regard the application of scientific objectivity, tolerance, and logic to problems which touch on religion, patriotism, politics, or sex as blasphemous, subversive, and immoral. And a surprising number of scientists feel the same way. Few of us are any more judicious or restrained, outside our laboratories, than the average layman. On the whole, we cooperate enthusiastically with the efforts which our nonscientific friends are making to run the world by tradition, prejudice, and simple inertia.

A program somewhat along the lines recommended by the committee is probably essential if science, as we

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know it, is to survive. Otherwise, we may expect an ever-increasing blanket of secrecy to cover the progressive degradation of science to the status of a weapon for cold war or hot, and ever-increasing suspicion, hostility, and misunderstanding to divide scientists from nonscientists. Such a program, though, will call for more courage, more action, and more conscious resistance to mass hysteria than most of us have been willing to contribute to date. During the recent years which were dominated by Joe McCarthy, the real point at issue was not the guilt or innocence of his victims. The real question was whether the American citizen could be punished for opinions as well as for acts—whether our traditional freedom of thought, freedom of association, freedom of movement, and freedom of speech were absolute or subject to the whim of any official who claimed to act in the national interest. The question was obviously of vital importance to scientists, yet scientific and technical societies took remarkably little part in the debate, and scientists as individuals applauded the witch-hunt about as often as they condemned it. We shall have to do better in the future if science is to have either the respect or the understanding of future generations.

WILLIAM PALMER TAYLOR
416 Ross Avenue,
Hamilton, Ohio

The suggested approach of the AAAS Committee on Science in the Promotion of Human Welfare is a fine beginning for restoring balance in the relationships between the scientist and the general public. As the committee comments, the problem is an acute one, becoming more so, and some sort of crash program is needed in these frightening times. In this light, I think the four-point program proposed—(i) stimulation of discussion among scientists, (ii) gathering of facts relevant to an issue, (iii) dissemination of reports to the public, and (iv) development of local liaison—is a good one.

However, with regard to points (iii) and (iv), I think an approach on a more vertical front than that proposed is required. The adult public as it now exists has little if any background in science and scientific thought. It has had schooling in which the study of science was largely avoided. This is true even of the political and economic leaders of our society. Many of those with college educations have had business or liberal arts training in which the science requirement has been at a minimum. Those with high school educations have had even less science.

There is therefore a poor foundation on which to build a structure of scientific awareness in our lay population. A man who has had no physics is not likely to grasp fully the implications of the nuclear revolution. A man with no biology or mathematics cannot really understand the problems of the population explosion. Although I do think we should attempt to reach the adult public according to the proposals advanced by the committee, I also think we have considerably more to gain by an expanded program directed toward our student population.

There is much talk of increased science teaching in our schools. However, it must be remembered that these curricula are still being run by the same administrators who were in charge before and who were dedicated to making school as easy as possible. They are the least well educated people in our educational system and are hardly qualified to administer a meatier program without guidance and support from scientists themselves. It appears to me that those schools which had strong science curricula before have them still and that those which had weak programs still have weak ones.

This is not to say we should educate all to be scientists. I am saying we can do a lot more to see that our students are taught enough science and scientific method of thought to enable them to consider the problems created by scientific advance and have some hope of solving them intelligently.

To be specific, I think we should (i) participate more, as individual scientists and in groups, in the educational affairs of our communities; (ii) create committees, if they do not already exist, to consult with state and national educational organizations and with state education commissions to impress upon them the importance of expanded science teaching in the schools; the committees should be prepared to present suggested curricula, textbooks, and teaching methods to these organizations. (iii) these activities should be conducted on a broad scientific front rather than by individual groups representing biology or chemistry or mathematics.

We are forced now to take almost defensive measures as scientists against a relatively ignorant and sometimes hostile public. By making greater efforts on behalf of our students, we should be able to look forward to a time when the general public will be aware of the peculiar methods and needs of science and of the problems created by scientific advance; will understand the difference between science and technology; will not exert the pressures which undermine scientific integrity; and will not have to be forced-fed a diet of science in order to gain some dim understanding of the tremendous changes occurring in the world.

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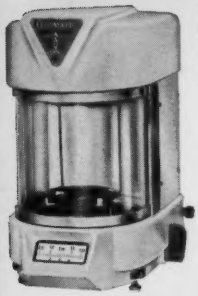

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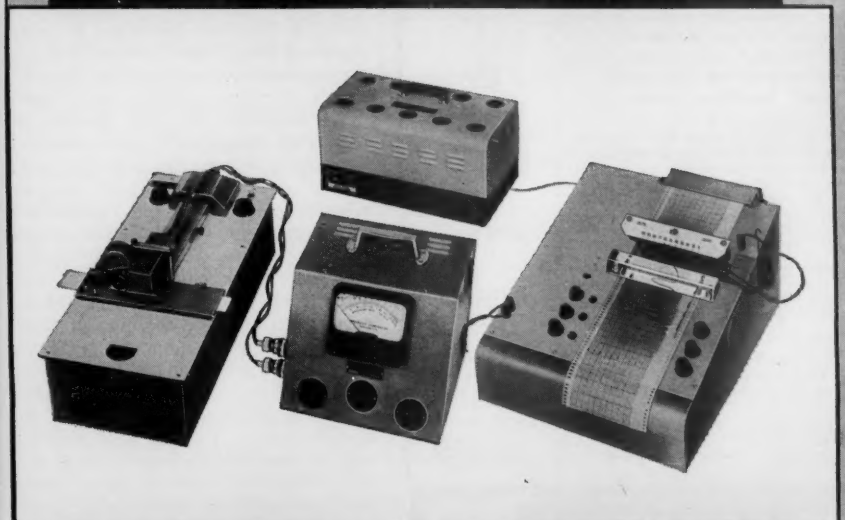

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Meetings

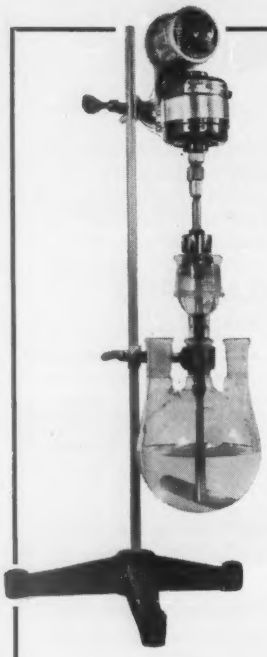
The Pancreas

A symposium on the pancreas, sponsored by the Mallinckrodt Foundation, was held from 23 to 25 May at Endicott House, Dedham, Mass. The discussion covered several phases—first, the pancreas as a whole with its anomalies, its injuries and infections and its tumors, both benign and malignant. The comments and conclusions may be summarized as follows. Most of the clinical tests for pancreatic function are relatively inaccurate. Pancreatic disease, once initiated, tends to be progressive. The volume of secretion from the pancreas is surprisingly large, amounting to several hundred cubic centimeters per day. There is no known disorder due to overfunction of the pancreas as an exocrine organ, although probably the reason alcohol makes pancreatitis worse is that it increases the amount of secretion produced by the still functioning portions of the pancreas.

Mucus is an important constituent of the pancreatic secretion, and disturbance in mucus secretion as part of a generalized disease process leads to the development of cystic fibrosis. The basic unit for exocrine function seems to be protein particles associated with the microsomal portion of the cell, which are concerned with making the enzymes. The key units probably come from the endoplasmic reticulum of the acinar cells. There is evidence that some type of feedback mechanism exists whereby the output of the proper enzyme is maintained to meet dietary needs. The particles of enzyme apparently require magnesium ions to maintain structural integrity. The enzyme particles form in the Golgi region, grow larger, and take up additional liponucleoprotein to become zymogen granules. The formed zymogen granule is from 0.5 to 1.5 micron in diameter. The nucleus seems to have a gene-governing function but does not participate directly in the process of enzyme formation. The zymogen granules pass by lacunar spaces through the cell membrane. The reaction of the fluid within the ducts is quite alkaline. It is possible that the bicarbonate which helps to maintain this alkalinity is secreted by the centroacinar cells.

Among other diseases that affect the pancreas as a whole are hemosiderosis and hemochromatosis; these are difficult to distinguish from one another and perhaps are the same disease process basically. The effects of the disturbed iron metabolism are apparent in the pancreas as well as in other organs of the body, and there is damage to practically all the cells of the islands indiscriminately, except that the alpha cells seem to be relatively free from iron pigment. When the beta cells are sufficiently involved in hemochromatosis, diabetes results:

Decrease in pancreatic exocrine function is largely due to inflammatory or obstructive processes. Obstruction is probably the most important in bringing about loss of exocrine function, and obstruction always leads to infection, which, in turn, tends to destroy additional pancreatic tissue. In general, the islands of Langerhans resist inflammatory and neoplastic processes. Administration of crude extracts of the pancreas in general constitutes satisfactory substitute therapy in the event of loss of exocrine function. While ectopic pancreatic tissue may take over to some extent for a damaged pancreas, the occurrence is rare and the mass is usually small. Usually ectopic pancreas carries ductal, acinar, and insular elements. Under certain conditions new formation of islands may occur, even in the diabetic patient. This has been observed both in man and in experimental animals. The new formation comes chiefly from the epithelium of the ducts. Under normal circumstances, cellular turnover in the islands is extraordinarily slow. With acute damage, as in alloxan poisoning and acute toxemic diseases, the beta cells may be particularly damaged



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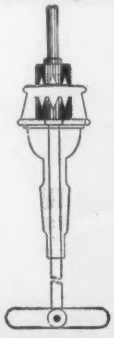

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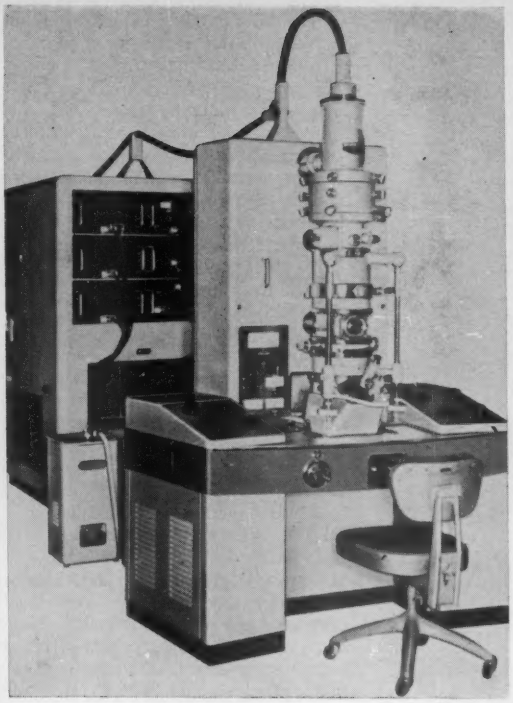

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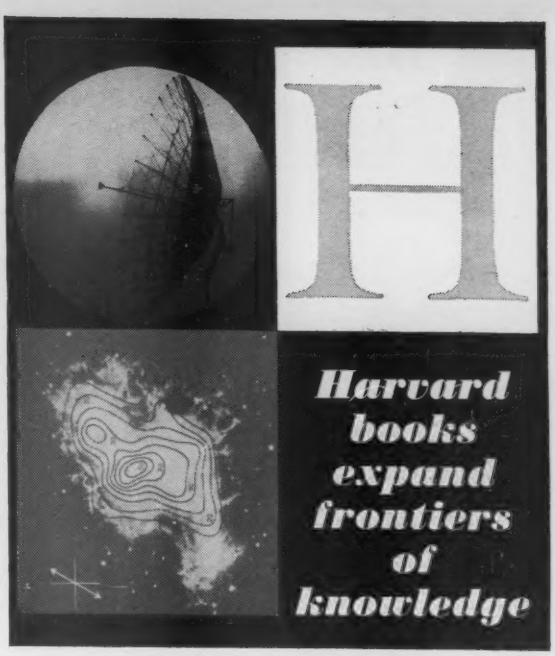

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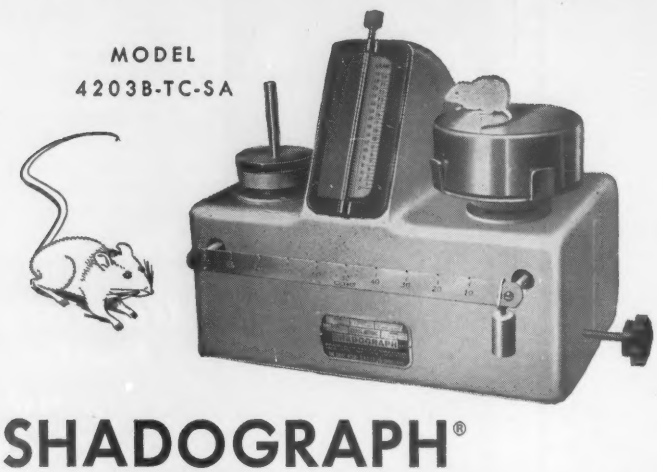

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SHIELDS WARREN
Cancer Research Institute, Boston, Massachusetts

Forthcoming Events

September

20–23. Conf. on Pure Food Laws, London, England. (Secretariat, Pure Food Centenary 1960, 14 Belgrave Sq., London S.W.1)

20–24. Aeronautics, 4th European cong., Cologne, Germany. (Wissenschaftliche Gesellschaft für Luftfahrt, Eberplatz 2, Cologne)

20–7. International Atomic Energy Agency, 4th general conf., Vienna, Austria. (IAEA, 11 Kärntner Ring, Vienna 1, Austria)

21–22. Industrial Electronics, 9th annual symp., Cleveland, Ohio. (G. E. Hindley, Reliance Electric & Engineering Co., 24701 Euclid Ave., Cleveland 17)

21–23. National Power Conf., Philadelphia, Pa. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

22. Society of Plastics Engineers, Binghamton, N.Y. (T. A. Bissell, SPE, 65 Prospect St., Stamford, Conn.)

22–23. High Temperature Resistance and Thermal Degradation of Polymers, symp., London, England. (Symposium Subcommittee, Plastics and Polymer Group,

Soc. of Chemical Industry, 14, Belgrave Sq., London, S.W.1)

22–26. Cancer Cytology, intern. conf., Madrid, Spain. (Miss E. L. Hughes, Pan American Cancer Cytology Soc., P.O. Box 633, Coral Gables, Fla.)

23–25. Inter-Society Cytology Council, annual, Chicago, Ill. (P. A. Younge, ISCC, 1101 Beacon St., Brookline 46, Mass.)

24–2. American Soc. of Clinical Pathologists, Chicago, Ill. (A. H. Dearing, 2115 Prudential Plaza, Chicago, Ill.)

25–28. American Inst. of Chemical Engineers, Tulsa, Okla. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36)

25–30. North American Assoc. of Alcoholism Programs, 11th annual conf., Banff, Alberta, Canada. (J. G. Strachan, Alcoholism Foundation of Alberta, 9910 103rd St., Edmonton, Alberta, Canada)

26–28. American Inst. of Electrical Engineers, petroleum industry conf., Oklahoma City, Okla. (R. S. Gardner, AIEE, 33 W. 39 St., New York 18)

26–28. American Soc. of Mechanical Engineers, petroleum mechanical engineering conf., New Orleans, La. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

26–28. Electronic Industries Assoc., natl. conv., Pittsburgh, Pa. (V. M. Graham, EIA, 11 W. 42 St., New York 36)

26–28. Standards Engineers Soc., annual, Pittsburgh, Pa. (J. A. Caffiaux, SES, 11 W. 42 St., New York 36)

26–30. Instrument Soc. of America, New York, N.Y. (W. H. Kushnick, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.)

26–1. Natural Rubber Research Conf., Kuala Lumpur, Malaya. (Rubber Research Inst. of Malaya, P.O. Box 150, Kuala Lumpur)

27–29. Relative Humidity and Paper Test Methods, symp., Grand Rapids, Mich. (Technical Assoc. of the Pulp and Paper Industry, 155 E. 44 St., New York 17)

27–30. American Rocket Soc.—Power Systems Conf., Santa Monica, Calif. (R. L. Hohl, ARS, 500 Fifth Ave., New York 36)

27–30. American Roentgen Ray Soc., Atlantic City, N.J. (N. Jones, 20 N. Wacker Dr., Chicago 6, Ill.)

27–30. Association of Iron and Steel Engineers, annual conv., Cleveland, Ohio. (T. J. Ess, AISE, 1010 Empire Bldg., Pittsburgh, 22, Pa.)

27–30. Medical Photography, 1st intern. cong., Cologne, Germany. (Deutsche Gesellschaft für Photographie e.V., Köln, Nurmarkt 49, Germany)

28–1. International Soc. of Audiology, 5th cong., Bonn., Germany. (Prof. Langenbeck, Baumschuallee 29, Bonn)

28–5. Pan-Pacific Surgical Assoc., 8th cong., Honolulu, Hawaii. (F. J. Pinkerton, 230 Alexander Young Bldg., Honolulu 13)

30–1. American College of Radiology, Atlantic City, N.J. (F. H. Squire, Presbyterian-St. Luke's Hospital, 1753 W. Congress St., Chicago 12, Ill.)

30–1. American Medical Writer's Assoc., Chicago, Ill. (H. Swanberg, 510 Maine St., Quincy, Ill.)

October

1–2. Enzymes in the Manufacture, Storage and Distribution of Food, symp., London, England. (Society of Chemical Industry, 14 Belgrave Sq., London (S.W.1)

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2–5. American Inst. of Mining, Metallurgical and Petroleum Engineers, fall, Denver, Colo. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18)

2–6. Water Pollution Control Federation, 33rd annual, Philadelphia, Pa. (WPCF, 4435 Wisconsin Ave., Washington 16)

2–7. American Soc. of Plastic and Reconstructive Surgery, Los Angeles, Calif. (T. R. Broadbent, 508 E. S. Temple, Salt Lake City, Utah)

3–5. Applied Spectroscopy, 7th symp., Ottawa, Canada. (C. R. Langdon, Aluminium Co. of Canada, Ltd., Arvida, Quebec, Canada)

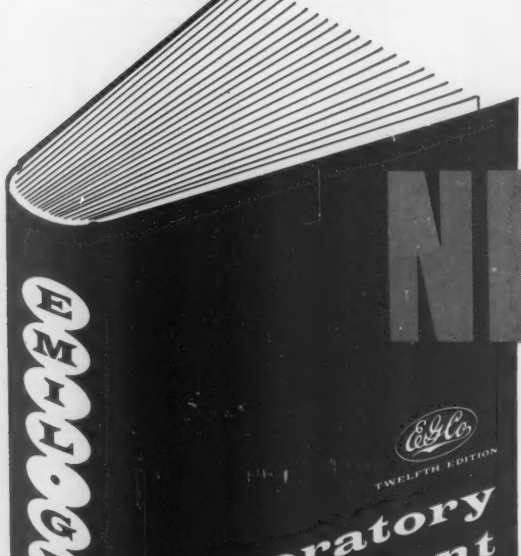
3–5. Communications, 6th natl. symp., Utica, N.Y. (B. H. Baldridge, Communications Symp., Light Military Electronics Dept., General Electric Co., Utica)

3–5. Nuclear Science, 7th annual, Gatlinburg, Tenn. (H. E. Banta, Oak Ridge National Lab., P.O. Box X, Oak Ridge, Tenn.)

3–7. Atomic Energy, 5th intern. seminar, Wiesbaden, Germany. (Mr. Trebst, Diplom-Volkswirt, Generalsekretär, Internationale Studiengesellschaft e.V., Theodorenstr. 6-8, Wiesbaden)

4–6. Radio Interference Reduction, 6th conf., Chicago, Ill. (S. I. Cohn, Armour Research Foundation, 10 W. 35 St., Chicago)

(See issue of 19 August for comprehensive list.)



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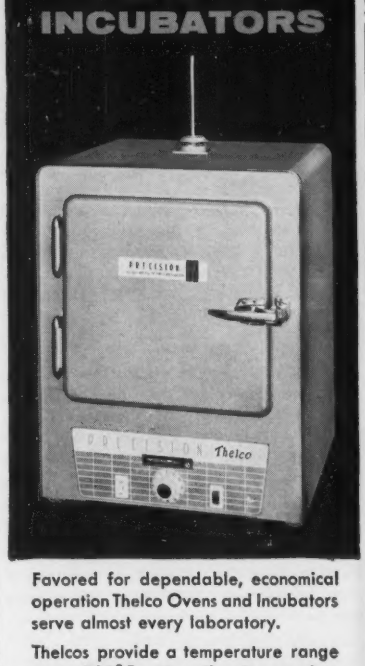

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■ INTEGRATING AMPLIFIER for use with chromatographs accepts the output of the chromatograph amplifier and produces an output to the recorder that is displayed as deflection from a base line. When the component has been completely eluted, the recorder trace again runs parallel to the base line. Height of the step measures area under the conventional chromatogram peak. Alternative output systems such as indicating meters or digitizers can also be used. (Jarrell-Ash Co., Dept. Sci711, 26 Farwell Street, Newtonville 60, Mass.)

■ 256 CHANNEL ANALYZER features preselected automatic programing; magnetic tape auxiliary memory; 600 to 2500 volts high-voltage power supply; single-push-button manual operation; and six modes of readout. Desired analyzer cycle of 12 operations, including accumulate, display, complement, print, and selective storage, can be preprogramed by patchboard. The analyzer automatically performs the specified operations at the touch of a single button. (Radiation Counter Laboratories, Dept. Sci713, 5121 W. Grove, Skokie, Ill.)

■ POTENTIOMETRIC RECORDER has been redesigned to increase flexibility and convenience. Among the changes are a constant voltage reference using a Zener diode and eliminating batteries, standard cell and standardizing mechanism; compartmented measuring circuit that interchanges as a unit for range changing; plug-in unit for multipoint recorders that interchanges to change number of points recorded from 2 to 24 points; plug-in amplifier unit. (Minneapolis-Honeywell, Dept. Sci714, Wayne and Windrim Aves., Philadelphia 44, Pa.)

■ SYNCHRONOUS MOTOR for slow speeds comprises two identical counter-rotating motors in a housing. One motor is connected to the 60 cy/sec line; the other, to a variable-frequency power supply. If the variable frequency is 60 cy/sec, the output shaft is stationary and opposes rotation with full motor torque. An increase or decrease of the variable frequency causes rotation forward or reverse. Motors can be supplied from 1/50 to 1 hp. (Genisco Inc., Dept. Sci725, 2233 Federal Ave., Los Angeles 64, Calif.)

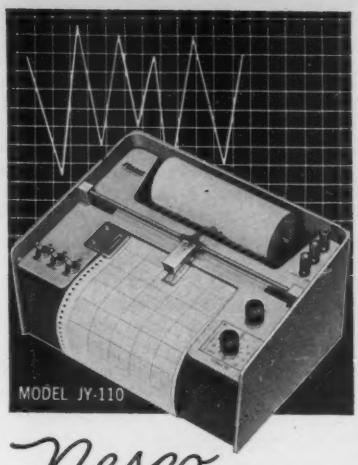
■ MAGNETIC TAPE PLOTTING SYSTEM permits plotting of digital computer results in continuous curve form on an X-Y recorder. The system includes a tape transport, a digital magnetic tape translator, a tape-control unit, amplifiers, and an X-Y recorder. The translator permits continuous plotting up to 4 in./sec of curve generated by a computer interpolating routine at information change rate of 100/sec. Point plotting at 100 points/min speed at ½-in. spacing is also provided. Accuracy is said to be better than ± 0.1 percent of full scale. (F. L. Moseley Co., Dept. Sci715, 409 N. Fair Oaks Ave., Pasadena, Calif.)

■ FREEZE-DRYING SYSTEM features condensing coils built into the vacuum drying chamber. Samples are frozen and dried in the same vacuum chamber. Forty pounds of product load or up to 1300 10-ml vials can be processed simultaneously. Cabinet is on casters for easy moving. (RePP Industries, Inc., Dept. Sci716, Gardiner, N.Y.)

■ INTERCHANGEABLE OPTICAL SYSTEM for the manufacturer's 1R-7 prism-grating infrared spectrophotometer extends the range of the instrument to the 200 to 700 wavemembers region. This extension of range is accomplished by equipping the interchange with a cesium-iodide prism and a 30-μ blaze, 30-line/mm, long-wavelength grating. The prism, grating, associated drive mechanisms, slit-program potentiometer, and frequency readout are mounted together on a casting that duplicates mechanically the original equipment. Replacement requires 2 or 3 minutes. (Beckman Instruments, Inc., Dept. Sci717, 2500 Fullerton Rd., Fullerton, Calif.)

■ SIGNAL GENERATOR generates wave shapes necessary for frequency and transient response tests of servo components and systems. These include forcing voltages for the servo and accessory wave shapes for cathode-ray oscilloscope display. Data frequency is covered in the ranges 0.01 to 1 and 0.5 to 30 cy/sec. Carrier frequencies from 60 to 2500 cy/sec are accommodated. (Industrial Control Co., Dept. Sci718, Central Ave. at Pinelawn, Farmingdale, N.Y.)

■ MONOCHROMATOR of large aperture, manufactured by Hilger & Watts, Inc., has available a range of interchangeable prism systems that cover the ultraviolet, visible, and infrared regions of the spectrum. The base is designed for use as a table model or for fitting to an accessory bar. Two instruments can be mounted together to function as a double monochromator. (Engis Equip-



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■ DIGITAL VOLTMETER converts an unknown input voltage into decimal number indication with accuracy said to be ±0.5 percent of full scale and full-scale response time 1/24 second. Both digital and quasi-digital indications are obtainable; in the latter the numbers move by the indicator window without framing. Input impedance is one megohm on all of three available ranges: 0 to 2.5, 0 to 25, and 0 to 250 volts. Ranges of 0 to 0.25 and 0 to 2500 volts are also available. Size is 6¾ by 4⅜ by 9 in. (Electro-Logic Corp., Dept. Sci726, 515 Boccaccio Ave., Venice, Calif.)

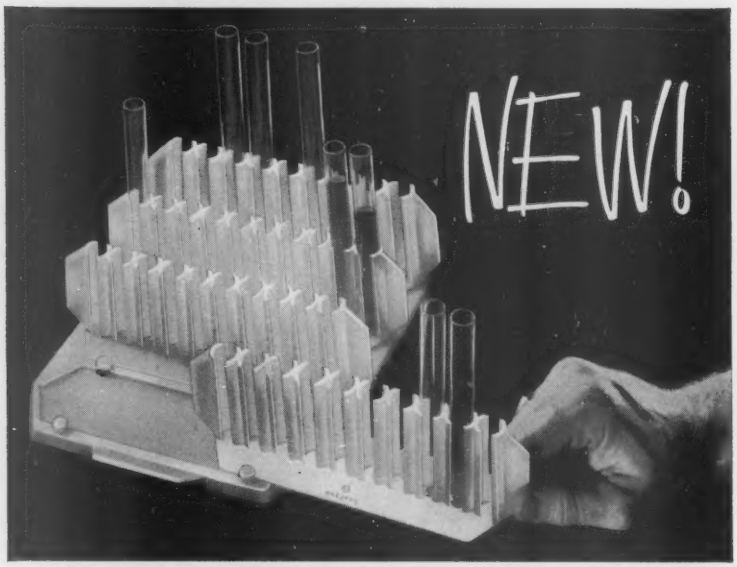
■ PHOTOGRAPHIC RECORDER uses 16-mm film to record up to 16 channels of information. From 4 to 32 hours of data can be recorded on 200-ft reels at speeds of 3 to 20 cm/min. The film is automatically developed within the recorder and can be viewed magnified ten times on the instrument's screen within 10 minutes. Date, time, and film number are printed on the film during recording. Trace width is 0.05 mm. With galvanometers, frequency response is d-c to 20 cy/sec or up to 150 cy/sec on special order. With a cathode-ray tube, d-c to 15 kcy/sec can be recorded. (The Geotechnical Corporation, Dept. Sci728, 3401 Shiloh Rd., Garland, Tex.)

■ SURGICAL SCINTILLATION DETECTOR consists of a basic detector, a selection of probes with crystals, and a tungsten-alloy collimator shield. The detector housing is 1 in. in diameter by 9¼ in. long. It contains a multiplier phototube and a transistorized preamplifier. Three beta-gamma sensitive needle probes and a manual scanning probe are furnished. The needle probes are: 2 mm in diameter by 10 cm long, 3 mm by 10 cm, and 6 mm by 15 cm. Each consists of a thallium activated cesium iodide crystal and a light pipe. The probes are sensitive only at the ends. An aural ratemeter indicating by change of pitch is available for use with the detector. (Nuclear Chicago Corp., Dept. Sci730, 333 East Howard Ave., Des Plaines, Ill.)

■ MATERIALS TEST SYSTEM is capable of simultaneously programing and applying rapid variations of temperature, load, and strain while recording each with respect to time as well as load versus strain. Applied force is continuously variable from −10,000 to +10,000 lb at rates up to 5000 lb/sec. Ram velocity is controllable from 0 to 1 in./sec throughout an 8-in. stroke. Two function generators are provided for translating pencil-drawn program charts into operating control signals. Program duration is adjustable between 10 and 300 seconds. (Research Inc., Dept. Sci731, P.O. Box 6164, Edine Station, Minneapolis 24, Minn.)

■ ARC-RESISTANCE TESTER provides 15 kv at 60 ma a-c for testing the ability of solid insulating materials to resist the action of an arc according to ASTM specification D-495. Voltage is continuously variable from zero. An electrode assembly, specimen holder, and a jig for sharpening electrodes are included. An interval timer with manual reset measures arc application time to the nearest 0.1 second. (Associated Research Inc., Dept. Sci733, 3727 W. Belmont Ave., Chicago 18, Ill.)

■ MAGNETIC-TAPE RECORDING SYSTEM is capable of recording two channels of wide-band information over the frequency spectrum from 10 cy to 4 Mcy/sec with amplitude response flat to ±3 db, and two auxiliary channels with frequency response 200 cy to 15 kcy/sec. Tape used is 2-in. wide, 1.0 mil, Mylar. A rotating magnetic head that records in a transverse fashion provides a head-to-tape speed of 1,300 in./sec with tape speed of 12.5 to 25 in./sec. Tracks are 0.010 in. wide and 0.015 in. on centers. The recording assembly is maintained at an operating temperature of 60°C to ensure stability of tape dimensions. (Ampex Data Products Co., Dept. Sci736, Box 5000, Redwood City, Calif.)



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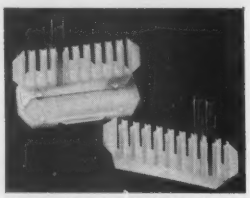

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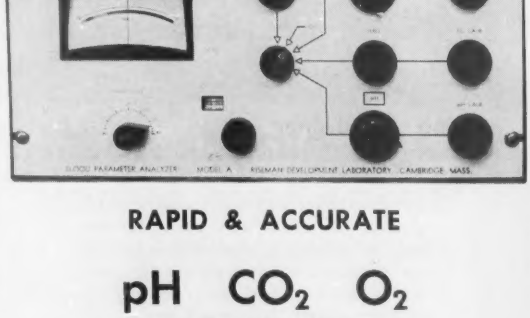

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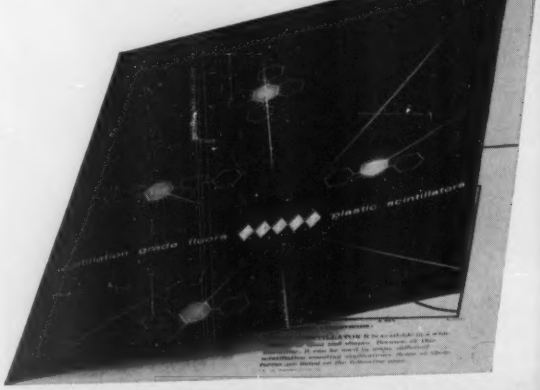

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■ DECIMAL-BINARY SWITCHES that convert decimal constants to a positional number code are available keyed to various binary code combinations, for example, straight binary, excess 3, 2-4-21, or gray. Selectors are available with eight or ten detented positions. Mounting area is 1.3 in.^{2} Rating is 0.5 amp inclusive, 1 amp resistive at 30 volts d-c. (Minneapolis-Honeywell Regulator Co., Dept. Sci727, Freeport, Ill.)

■ MICROTOME KNIFE SHARPENER will accommodate any microtome knife up to and including 185 mm. The sharpening process is automatic, the operator being required to insert the knife into a holder and to apply honing compound to a vibrating glass hone plate. An electric timer is set to stop the operation. Subsequent hand stropping is said to be unnecessary. (American Optical Co., Dept. Sci729, Buffalo 15, N.Y.)

■ MINIATURE PRINTER operates at speeds of more than 30 characters per second. The device is 9¼ in. long and fits into a standard 3-in. instrument case with self-contained paper supply. Output is a 5/16-in. tape. (Potter Instrument Co., Dept. Sci732, Sunnyside Blvd., Plainview, N.Y.)

■ TEFLON BOTTLES available in 1-, 2-, and 6-liter sizes are of one-piece, molded construction. Stoppers and pouring spouts are also of Teflon and are fastened by a stainless-steel screw-lock arrangement. (Chemplast Inc., Dept. Sci742, 3 Central Ave., East Newark, N.J.)

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■ LABORATORY HOMOGENIZER is said to be capable of processing samples as small as 1 oz with results equal to the quality obtainable with production homogenizers. Up to 8 gal/hr may be processed. All contact parts are 18-8 stainless steel. Thermostatically controlled heater is an optional accessory. (C. W. Logeman Co., Dept Sci740, 633 Bergen St., Brooklyn, N.Y.)

■ EVAPORATOR UNIT for concentration of radioactive samples is said to incorporate a technique that inhibits deposition of material on any but the collector surface. Liquid capacity is 1000 ml. Two to three hours are required to concentrate 90 percent of all radioactive materials on a 2-in. planchet, with area of deposition variable between ½ and 2 in. Heating unit is self-contained. (Nuclear Corporation of America, Dept. Sci743, Denville, N.J.)

■ HIGH-VACUUM STOPCOCK with Teflon plug uses O-rings to provide vacuum seals. The seals are designed to prevent leaks from one side arm to the other as well as at each end of the borosilicate glass barrel. Single or double oblique bores are available. (Scientific Glass Apparatus Co., Dept. Sci744, Bloomfield, N.J.)

■ BALANCE available in capacities of 1000, 2000, and 4000 gm, is said to indicate correctly in spite of off-level conditions. No addition of weights is required within the range of indication. Removal of a substitution weight extends the range. The balance is magnetically damped. (August Sauter of New York, Inc., Dept. Sci746, 866 Willis Ave., Albertson, N.Y.)

■ DEAD-WEIGHT GAGE is operated with water. Weights are supported on a tube, the upper end of which is supported by a platform operated by the piston. A mechanical stop prevents disengagement. Accuracy of ±1/20 percent is said to be standard and ±1/30 to be obtainable by selection. Construction material is 416 stainless steel. (Mansfield and Green, Inc., Dept. Sci763, 1051 Power Avenue, Cleveland 14, Ohio)

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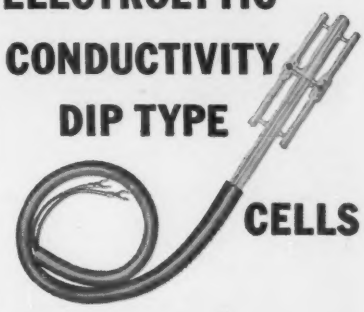

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■ VAPOR DETECTOR for acetone, alcohol, and hydrocarbons is said to detect concentrations in the parts-per-billion range. The detector utilizes the flame ionization principle, measuring electron concentrations resulting from the introduction of the vapor into a pure hydrogen flame. Response is said to be linear up to concentrations of 2 percent. The instrument is portable, operating from self-contained batteries. (Carad Corp., Dept. Sci735, Redwood City, Calif.)

■ PNEUMATIC SIGNAL CONVERTER receives any standard square-root or other pneumatic signal in the range 3 to 15 lb/in.^{2} gage, and uses this signal to position a cam. A pneumatic tracing device senses the profile of the cam and, through a relay, transmits a converted pneumatic signal corresponding to the cam. Sensitivity is said to be better than 0.2 percent, accuracy ± 1 percent of full scale or better, and speed of response less than 0.5 second for full scale. (Brooks Rotameter Co., Dept. Sci739, P.O. Box 432, Lansdale, Pa.)

■ LOADING REACTOR is designed to provide a convenient inductive load that can be made adjustable by using it with a variable transformer. It consists of a gapped, strip-wound, toroid-core wire wound and embedded in epoxy compound. Ratings are: 120 volts, 60 cy/sec, 2 amp continuous, 3 amp intermittent, inductive reactance 60 ohms, resistance 4 ohms, inductance, 0.16 hy. (Superior Electric Co., Dept. Sci737, 83 Laurel St., Bristol, Conn.)

■ TEMPERATURE CONTROLLER uses a servo null-balance system to indicate controlled temperature on a 10-in. scale. Time-proportioning or on-off control, with or without anticipation, is available. Control stability of the proportioning model with anticipation is said to be ±0.1°F and indication accuracy ±0.5 percent of full scale. Alarm contacts can be included. (Electronic Processes Corp. of California, Dept. Sci748, 436 Bryant St., San Francisco, Calif.)

■ SWITCH CIRCUIT ASSEMBLY for application to digital systems produces a single square-wave output pulse, synchronized with an external clock pulse, in response to each operation of the push button. Clock pulse frequency can be 4 to 500 kcy/sec. The transistor electronic circuit used is an integral part of the switch with all components sealed in a resilient potting material. (Minneapolis-Honeywell Regulator Co., Dept. Sci749, Freeport, Ill.)

■ TELEMETRY DISCRIMINATOR uses the phase-lock technique to obtain good selectivity on each of 23 standard telemetry channels. Sensitivity is 10 mv r.m.s. to 14.5 Kcy/sec and 70 mv r.m.s. at 70 Kcy/sec. Stability is said to be ±0.5 percent of bandwidth and linearity 0.1 percent. Output is ±90 volts at ±25 ma. Trimming potentiometers on the front panel are used to adjust frequency range of each channel. Controls include output gain, output zero, and bandwidth. (Hallamore Electronics Co., Dept. Sci758, 714 N. Brookhurst St., Anaheim, Calif.)

■ DIFFERENTIAL AMPLIFIER features input resistance greater than 500 megohms, voltage gain from 2 to 50, and linearity ±0.05 percent. A mechanical chopper and silicon-transistor carrier amplifier are used. Output voltage range is ±5 volts. Power consumption is 140 ma at 28 volts unregulated. (Dynamics Instrumentation Co., Dept. Sci759, 583 Monterey Pass Rd., Monterey, Calif.)

■ PHOTOCONDUCTIVE CELLS have power rating of 0.5 watt when used with heat sink and 0.25 watt without heat sink. The type 504 is a cadmium selenide cell with relatively high speed of response; the type 505 is a cadmium sulfide cell. Nominal resistances at a color temperature of 2870 and 2 ft-ca are 1500 and 5000 ohms, respectively. Peak spectral responses are 5500 and 6900 respectively. Dimensions are ½ in. in diameter by ½ in. long. (Clairex Corp., Dept. Sci761, 19 W. 26 St., New York, N.Y.)

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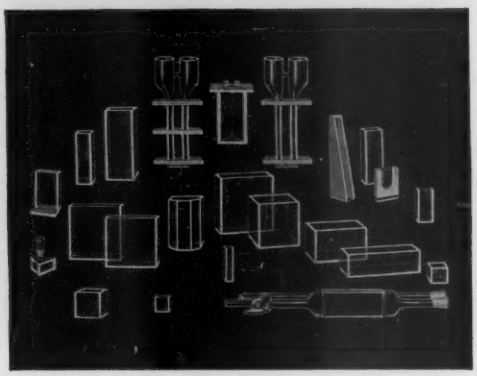

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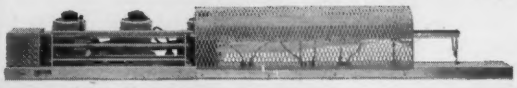

Micro-Incinerator

This apparatus is used to reduce tissue sections to ash without disturbing the exact topographical arrangement of the residue. Micro-Incineration gives information as to the location and amount of the total minerals in cells and tissues which has been lacking in other histochemical procedures. Reference—American Journal of Anatomy, Vol. 53, 1933, page 243.

CAT. No. 9-96

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As we are planning an extensive line of special-purpose sprays, we invite your suggestions.

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Stock No.	Type Pkg.	Name	Application
NIN-3	8 oz. can	NINHYDRIN	a-amino acids & amines
ISA-2	8 oz. can	ISATIN	Proline, Phenylalanine derivatives, & Sulfur-amino acids
BCG-04	8 oz. can	BROM CRESOL GREEN	Acidic & Alkaline compounds
TTZ-1	6 oz. bot.	TRIPHENYL TETRAZOLIUM	Steroids containing reducing groups
ADA-2	6 oz. bot.	ANILINE DEPHENYLAMINE	Carbohydrates
PRO	8 oz. can	PROTECTIVE LACQUER	Chromatogram paper & misc. labels

To preserve chromatograms sprayed with NINHYDRIN, Zweig recommends treatment with the following (ref. Zweig, G., Anal. Chem. 28, 428, 1956):

NFX	6 oz. bot.	NINHYDRIN FIXER	For Ninhydrin
NTL	6 oz. bot.	NINHYDRIN NEUTRALIZER	Chromatogram
PRO	8 oz. can	PROTECTIVE LACQUER	Preservation

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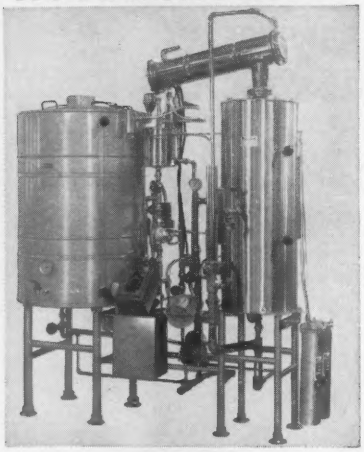

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■ SCHERING BRIDGE manufactured by Hartmann and Braun in Germany measures dielectric loss factor and capacitance of grounded or ungrounded test objects at high and low voltage and dielectric constant of solid and liquid insulating materials. The test object is compared with a loss-free standard capacitor by means of an a-c bridge. Measuring range for capacitance is 3 pf to 10μf and for loss factor 2×10^{-5} to 1.111. Loss-free compressed-gas reference capacitors are supplied. (Epic Inc., Dept. Sci738, 150 Nassau St., New York 35, N.Y.)

■ AUTOMATIC SAMPLE CHANGER is designed to handle up to 200 samples for radioactivity measurements. Models are available for gas-flow or scintillation counting or for both. A feature of the instrument in an automatic reverting circuit that avoids excessive time for counting low activities. Samples of normal activity are timed for full preset count; low-count samples are timed for a small fraction of the preset count and this reversion is recorded and identified on the output tape. (Technical Associates, Dept. Sci741, 140 W. Providencia Ave., Burbank, Calif.)

■ REFERENCE RADIOGRAPHS for inspection of aluminum and magnesium castings include 13 covering discontinuities in aluminum alloy castings and 12 for magnesium alloy castings. Each radiograph illustrates eight grades of severity for a particular discontinuity. Illustrated are gas holes, segregation, microshrinkage (both sponge and feather), and foreign matter. Each standard is held in an 8½ by 11 in. cardboard frame. (American Society for Testing Materials, Dept. Sci747, 1916 Race St., Philadelphia 3, Pa.)

■ TEMPERATURE INDICATING LABELS provide a change from pastel to black to give an irreversible record of exposure to heat. The labels are available in 50°F steps. From 100° to 500°F they are offered in plastic casing and from 500° to 1100°F on stainless-steel foil. Both types are self-adhesive and are said to adhere until intentionally removed. (Pyrodyne, Inc., Dept. Sci751, c/o William Wahl Corp., 11973 San Vincente Blvd., Los Angeles 49, Calif.)

■ RELAY TESTER measures pull-in and drop-out voltage and current simultaneously. Coil voltage is continuously variable. Automatic driving circuitry provides three repetition rates. Contact resistance and coil resistance are measured by a built-in ohmmeter. Connections are provided for oscilloscope display. (Anaheim Electronics Division of Electronic Engineering Co., Dept. Sci755, 1601 Chestnut Ave., Santa Ana, Calif.)

■ INFRARED SPECTROPHOTOMETER uses a prism-grating monochromator and a ratio recording system in a two-frequency, dual-beam system with beam chopping ahead of the sample. Cell space is over 10 in. long. Manufacturer's specifications include the following: wave-member accuracy ± 0.5 cm^{-1}; wave-member reproducibility ± 0.1 cm^{-1}; photometric accuracy ± 0.1 percent; resolution 0.3 cm^{-1} or better. Range is 4000 to 450 cm^{-1} by use of KBr prism and windows. Photometric scales of 0 to 1, 0.5 to 1.5 absorbance, and 0 to 100 percent transmittance are provided, as well as a compound scale and expanded scales. Spectra from 18 in. to 150 ft in full-span length are recorded without gaps at order-change points. (Applied Physics Corp., Dept. Sci765, 2724 S. Pack Rd., Monrovia, Calif.)

■ CAPACITANCE INDICATOR uses a crystal-controlled oscillator to furnish 1.6 Mcy/sec excitation to two matched, tuned circuits. One, the measuring circuit, contains the capacitance being measured; the other is a reference circuit. Ranges are 0 to 200 pf on narrow-span setting and 0 to 2800 pf on wide span. Corresponding sensitivities are 0.01 and 0.19 pf, respectively. Calibrated accuracy is said to be ± 2.0 percent. A ± 10-volt variation of input voltage produces a ± 50°F ± 10 percent zero shift. The instrument is portable, measuring 11 by 12 by 6 in. and weighing 19 lb. (Foxboro Co., Dept. Sci764, Foxboro, Mass.)

■ ROBOT CHEMIST is a modularized system for automatic chemical analysis. The operator is required only to load samples in a storage rack that holds up to 100 samples. An index head performs a sequence of operations of types depending on special-purpose subassemblies and determined by programmer settings. Operations include pipetting aliquots of sample, adding measured amount of reagent, mixing, discarding sample, rinsing and draining container, rinsing and draining pipette. Samples are maintained at constant temperature through operations. An automatic centrifuge loads, spins and unloads 12 samples in each cycle. Operating sequence is varied by resetting switches. Examples of analyses performed include amino acid chromatography, blood sugar by glucose oxidase method, serum lactic acid by dehydrogenese method. The system is compatible with standard laboratory colorimeters, spectrophotometers, radiation counters, *p*H meters, and so forth, (Research Specialties Co., Dept. Sci767, 200 S. Garrars Blvd., Richmond, Calif.)

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Microbiologist. Ph.D. (in Turkey), 4 years' experience with fermentation microbiology; 2 years' experience with microbiological methods in biochemistry field (postdoctoral fellowship in America); available for research technician anywhere; married, 3 children. Box 171, SCIENCE. X

(a) **Physiology,** recent Ph.D., human anatomy, zoology minors; prefers research in respiratory-metabolic physiology or teaching position. (b) **Entomology** Ph.D., parasitology minor; one year medical student; available for academic or commercial appointment. S8-4 Medical Bureau, Inc., Science Division, Burneice Larson, President, 900 North Michigan Avenue, Chicago.

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B.S. or M.S. Industrial Toxicology Laboratory. Perform and supervise performance of acute and chronic oral toxicity tests and reproduction studies. Previous experience in this area desirable. Experience in general handling and experimental use of small animals necessary. Ability to perform routine statistical analysis of data necessary. Salary commensurate with training and experience. Please address replys to Mr. Charles R. Young,

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Opportunity available for young physician in physical service department of medical division. Should have ability and interest in medical writing. Clinical or laboratory experience desirable. Please send résumé to **Technical Employment Coordinator, Upjohn Company, Kalamazoo, Michigan**

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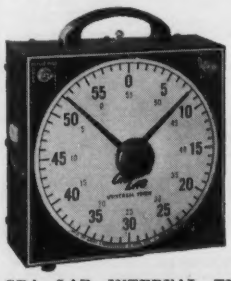

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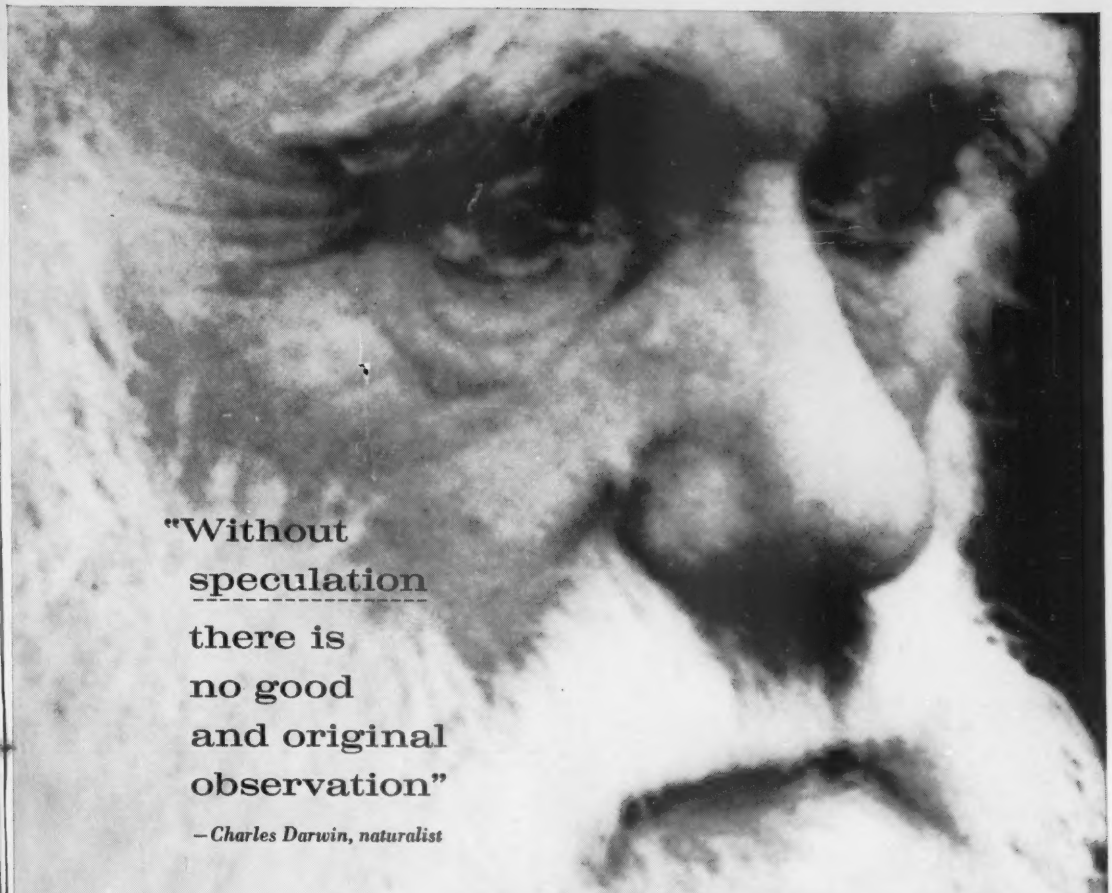

Man's search for scientific knowledge and understanding has its taproots in the above thought expressed by Darwin in a letter to his distinguished contemporary, Alfred Russel Wallace, in 1857.

Speculation—intuitive contemplation guided by past discoveries—led Darwin to his famous observations set forth in *Origin of Species*. Similarly, it led Alexander Graham Bell to the invention of the telephone—and has since led to many major advances in electrical communications.

At Bell Telephone Laboratories, the puzzling flow of current in semiconductors provoked speculation which yielded the transistor—and a Nobel Prize. Speculation about the behavior of the electron led to experimental proof of its wave nature—and another Nobel Prize. "Brains" capable of guiding missiles and space probes first took form in the bold speculations of Bell Laboratories scientists.

Today, Bell Laboratories scientists and engineers are more keenly aware than ever of the importance of speculative thinking. The far-reaching scientific and technological developments of tomorrow are already the subject of advanced research. Among them are radically new materials and devices—basically new switching systems, transmission via satellites, and waveguide networks able to carry hundreds of thousands of voices simultaneously.

Through informed speculation about Nature's laws, Bell Laboratories will continue to search for the "good and original observations" which are so vital to the ever-improving Bell Telephone System.

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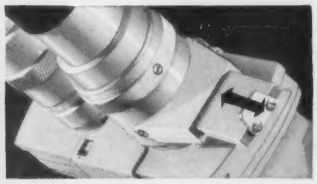
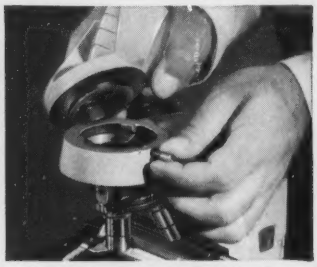


New Bertrand Lens Built-in Bertrand lens is now supplied as standard on all binocular and trinocular Phasestars to provide new convenience. You slide lens into position in eyepiece tube and raise or lower to focus quickly on diffraction plate at back aperture-of objective.



Interchangeable, Rotatable Bodies Your choice of interchangeable, rotatable, monocular, binocular or trinocular bodies. Simply loosen thumb screw to rotate (full 360°) or interchange. Special inclined monocular body with vertical photographic tube also available.

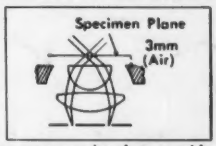
Interchangeable Stages You loosen single set screw to remove and interchange stages... your choice of graduated or ungraduated mechanical or MICRO-GLIDE stages.

The AO Spencer Phasestar is the most versatile phase microscope ever developed. Beginning with a basic Phasestar stand, you can select from a wide choice of interchangeable bodies, stages, optics and phase accessories to make up the specific model that meets your exact needs...all in all, more than 50 possible combinations or models to choose from. And whatever the model you choose, you're assured of superior AO Spencer quality *plus* matchless convenience, comfort and versatility.

Often particular phase applications require specific equipment and phase contrast objectives. Before you select your phase microscope and accessories consult your AO Sales Representative. He's qualified to help you select the microscope and equipment you need to do the job. There's no obligation, of course.

AO SPENCER PHASE ACCESSORIES FOR PLATELET COUNTS

The use of phase contrast for blood platelet counts is increasing in acceptance and application. The longer working distance required with the phase hemacytometer can be obtained with special AO Spencer long working distance accessories that provide up to 7mm working distance in air or 10½mm in glass.



SPENCER

American Optical Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

Dept. H-4

☐ I would like to review a specific phase microscopy problem. Please have AO Sales Representative call.

☐ Please send copy of Phasestar Brochure.

Name_____

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